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Ontario

POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5, 6, 1967

at the

Inn On The Park

TORONTO, ONTARIO

(4)

TABLE OF CONTENTS

Table of Contents, Continued

Table of Contents, Continued

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"OPENING ADDRESS"

THE HONOURABLE J. R. SIMONETT
MINISTER OF ENERGY AND RESOURCES
MANAGEMENT

The problem of pollution resulting from man's various activities is not a new one. In England, in the sixteenth century, Queen Elizabeth I is reported to have complained of the unpleasant smoke created by burning coal in open fires in London and certainly the lack of sanitation in most cities of that time created conditions which today would be considered as intolerable. So, when we look back over the past few hundred years, we see that progress has been made in pollution abatement but we also see that increasing human population and increasing industrialization tend to cancel the progress being made in control programs.

In Ontario, since the late 1940s, we have experienced both a substantial increase in population and a marked expansion of industrial activity. We look upon these as achievements rather than problems but only with an awareness of the potential problems of pollution and an expanding program of abatement can we continue to develop in a healthy environment, enjoying those pursuits of leisure which we earn by the fruits of our labour.

During the past 20 years or so, the complexity of the overall pollution problem has increased greatly and the governmental agencies involved in dealing with the problem have increased correspondingly. Originally, the Department of Health accepted responsibility for all pollution abatement programs until 1956, when the Ontario Water Resources Commission was formed, taking over the management of water pollution abatement. Since then, the Department of Lands and Forests and the Department of Agriculture and Food have become involved in controlling the now widespread use of pesticides and herbicides. In addition, the Department of Mines has become increasingly involved in mines tailings disposal, and the Department of Municipal Affairs has been made aware, by the municipalities, of the very rapid growth in the amount of solid refuse which has to be disposed of daily from our urban centres.

At first glance, these appear to be separate problems, each with a specific governmental agency responsible for dealing with it, but a closer inspection reveals the fact that these problems are all inter-connected. Let me give you an example; refuse disposal is a municipal responsibility -- if it is incinerated, we have air pollution which is a Department of Health problem; if it is dumped in a low-lying area, it is likely to pollute a natural watercourse which makes it an Ontario Water Resources Commission problem. Realizing the need for close liaison within Government among the various agencies involved, the Prime Minister established in 1966 a committee of deputy ministers known as The Advisory Committee on Pollution Control. Since its formation, this committee has established co-ordination of programs while leaving the actual responsibility for action with the various member departments. This conference is being sponsored by the Advisory Committee, the Chairman of which is your Chairman this morning, and my deputy, Mr. Thatcher.

Pollution of our environment is a by-product of human activity and we cannot eliminate it entirely. We can reduce it to a greater or lesser extent depending on what we are willing or able to pay. For example, a factory may be able to produce the goods we need very cheaply but it may create, as a result, gross air or water pollution. Alternatively, we may reduce the pollution to the point of being negligible but we may force an increase in the price of the goods beyond what we can afford to pay. Obviously, these are extremes and neither is the best solution. What we need is a solution somewhere between the extremes which will provide us with the goods we need, at a price we can afford, while creating no more pollution than we are prepared to tolerate.

In my view, the best means of achieving a way of life that satisfies us all to the greatest possible extent, is to make every member of our community aware of the problem so that he can help make the value judgments which must be made if abatement programs are to be tailored to the needs of the people. This, then, is the main purpose of this conference -- to provide information and answers -- to frankly acknowledge those areas where progress is slow because of a need for additional knowledge -- to discuss which areas need more research and to tell you of some of the progress being made. It may also help to dispel some of the doubts and confusions in the minds of many people concerning what is actually happening in pollution of our air, soil and water. Is it increasing? Is it being controlled? What are the issues?

I hope that this conference will provide the answers to these questions.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"THE NATURE OF THE PROBLEM --- AIR POLLUTION"

MR. R. L. STOCKMAN, PRESIDENT,
AIR POLLUTION CONTROL ASSOCIATION,
SEATTLE, WASHINGTON.

It is indeed a pleasure and an honor to speak to you today as a representative of the 4500 members of the Air Pollution Control Association. I bring you greetings from the Association and I am proud to tell you that many of our members are from Canada, and, of course, from the Province of Ontario. Many of your members have contributed substantially to work of the Association. Your Mr. Harry Belyea served as our President in 1960 and Mr. W. Bradley Drowley is now doing an excellent job as a Vice-President and member of the Executive Committee.

The Air Pollution Control Association is truly an international organization with members from many countries. In particular, however, the membership from Canada makes this so. Canada and the United States have always worked well together on their common problems and it is my personal observation that, as we tackle the problem of air pollution, our relations are becoming even more closely cemented. I am especially aware of this through the activities of the Pacific Northwest International Section of the A.P.C.A. in which I have been deeply involved for some time working with the good people of British Columbia. As some of you may know, the International Joint Commission is currently proceeding in a methodical evaluation of existing or potential problems of air pollution along our common border.

I would like also to take this opportunity to bring you greetings from Governor Daniel J. Evans and the State of Washington. Governor Evans is vitally concerned with the quality of our environment and is providing great leadership and support in the challenge of managing our air and water resources.

In the United States, the early battles against air pollution were fought with pitifully few resources in a few cities where visible air pollution had become so obvious that it was no longer tolerable. It was not until episodes seriously affecting the health of people were recognized, until significant economic damage to crops and animals was established, and until the then new phenomenon of photochemical smog in California was diagnosed that there was any substantial recognition of air pollution as much more than a visible and unpleasant nuisance.

This has all occurred in a relatively few short years in the span of modern times. It was not until the early 1950's that the United States reached any serious recognition of this problem as one of national concern. Since that time much has happened in both the growth and understanding of the problem and the development of effective efforts at the federal, state, and local level. It was my pleasure on November 21st last to be present at the White House when President Johnson signed the latest amended version of the Clean Air Act. This action is another giant step forward in providing more and more effective tools at the federal, state, and local level to fight the battle. As the United States pursues its actions, there is much that it can learn from and share with England, Canada, Australia, and others. One of the important mechanisms for doing this is through the activities of the Air Pollution Control Association and, especially, its participation in the International Union of Air Pollution Prevention Associations.

Let us, briefly, go back in time to look at this problem. From the beginning of civilization and the first time man learned how to build a fire, we have, knowingly or unknowingly, utilized the air around us for the disposal of byproducts and wastes of man's activities. This has grown to the extent that now there is probably no place on earth where contaminants generated by man have not, at some time, been present. This is dramatically emphasized by the fact that we can and have detected debris from nuclear testing on a global scale.

Note that I indicated we have the technological capability to detect this material just as we have the ability to detect many other kinds of materials. The mere detection or knowledge of the presence of a foreign material is, of course, not enough. We will always utilize the capacity of the ambient air to receive and disperse byproducts and waste. Our challenge is to understand the receiving capacity of the atmosphere, to determine the concentration of contaminants that is significant, and to manage our activities so as to stay well within these concentrations. Concentrations and effects of air contaminants can be called criteria. From these, standards of air quality and standards for control can be developed.

There are those who are concerned about the buildup of carbon dioxide concentrations in the air on a global scale and its possible effects on the climate. This is a proper concern as a long-range consideration and deserves its share of research effort. The answer to this question and others like it, however, are not the kind of thing we can wait for before launching our attack on the obvious problems.

Let us come down to earth now and look at the situation as it exists in that shallow layer of air at man's breathing level where he lives, works, and plays. To have an air pollution problem, we must have an air contaminant source, an atmosphere to transport or concentrate the contaminants, and people or their property to be affected.

First of all -- people. Pollution is a people problem. People like to congregate. We are all moving to the city. Where there are more than two people, anything that one does affects the other. As we multiply this by the thousands of millions, we not only have almost countless sources of air contaminants ranging from the driving of our cars and heating of our homes to operating our big factories -- but we also have all of these people whose health, possessions, economic well-being, comfort, and general welfare can be affected when air contaminant levels get out of hand.

Second, let's look at the air contaminants. An air contaminant may be considered as any matter in the atmosphere which is foreign to the natural makeup of so-called pure air. We are primarily interested in air contaminants which occur in the atmosphere as a result of man's activities. When an air contaminant, or combinations of air contaminants, become sufficiently great, adverse effects occur. At this point, we have air pollution.

Air contaminants may be broadly classified as large particles, aerosols, or gases. I think of large particles as those over about 40 microns in size since they are large enough to have a tendency to settle rapidly. They generally cause a nuisance condition -- although more severe effects will occur if the material is corrosive, or if it has adsorbed, or absorbed, toxic or corrosive gases. The smaller particles, or aerosols, tend to remain suspended in the atmosphere and include such particles as smoke, fumes, and fine mists. Smoke, containing both solid and liquid particles, is the result of incomplete combustion. It is most commonly associated with the burning of rubbish and fossil fuel, the burning of wood, and may be produced from an improperly-operating motor vehicle.

Fumes are solid particles from the condensation of vapors from volatilized solid matter. They are most commonly associated with manufacturing processes -- particularly, the metals, chemical, paint, and rubber industries.

The dusts, both small and large, are most commonly generated from sawing, drying, grinding, and materials-handling activities, and are commonly found at such industries as asphalt, metal, cement, rock, dry foods, lumber, for example.

When a particle is in a liquid form, it is called a mist. The simplest examples are fog and steam. Mists emanate from a number of industrial processes, including spraying, coating, and impregnating.

There are a wide variety of gaseous contaminants. Gases tend to mix and diffuse in the atmosphere more rapidly than particles. Sulphur dioxide, oxides of nitrogen, carbon monoxide, hydrocarbons, aldehydes, acids, fluorine, and other compounds containing nitrogen, chlorine, and sulphur are the most common gaseous air contaminants.

Sulphur dioxide comes, most commonly, from the roasting of sulphur-containing ores and from the burning of fossil fuels. It has a suffocating odor, may damage vegetation, and may be converted to sulphur-trioxide and sulphuric acid mist under foggy conditions.

The oxides of nitrogen are produced by the combustion of fuels and by some chemical manufacturing processes. In combustion, the natural atmospheric nitrogen is converted to the oxide at elevated temperatures. All burning operations, including a major source, the motor vehicle fuel combustion, produce the nitrogen oxides. At high concentrations nitrogen dioxide can be toxic and can change the color of the atmosphere. At the usual concentrations experienced, however, its primary significance is its role in the formation of photochemical smog.

Carbon monoxide results from incomplete combustion of carbonaceous materials. It has an adverse effect at high concentrations such as those that might be found in a garage, or in areas of heavy traffic. The motor vehicle is the major contributor.

Hydrocarbons, containing only hydrogen and carbon, has as a chief source the incomplete combustion of fuel in the motor vehicle. Hydrocarbons in the usual concentrations experienced are not a problem, but, like the oxides of nitrogen, are associated with the formation of photochemical smog under the influence of sunlight.

Aldehydes contain carbon, hydrogen, and oxygen, and may be formed as a result of incomplete combustion or from the action of sunlight on nitrogen dioxide and olefinic hydrocarbons in the atmosphere. Some are associated with eye irritation as experienced in photochemical smog.

Acids (of the organic type containing carbon, hydrogen, and oxygen) are formed chiefly by incomplete combustion -- some in industrial processes and others in the photochemical process. Some inorganic acids are of concern. The chief one is hydrogen fluoride which can damage vegetation at very low concentrations.

Odorous gases are one of our more difficult problems to handle. The most important ones are complex sulphur or nitrogen compounds. Chemical manufacturing, food processing, dumps, slaughter houses, and kraft mills are among the major sources. They create a nuisance and adversely affect property values.

Photochemical smog has been mentioned several times. Photochemical smog is primarily the result of photo-activated nitrogen dioxide reacting with hydrocarbons under the influence of sunlight. Both the oxides and the hydrocarbons are at concentrations which are otherwise not particularly important to us. The new compounds formed can result in eye irritation, vegatation damage, odor, rubber-cracking, and small liquid particles which obscure visibility. These compounds can be called secondary contaminants. Primary contaminants, then, are those which enter and remain in the atmosphere in their original form.

Third, let's look at the weather. The atmosphere is a highly variable and fickle receiving stream. It changes hour by hour. It is much more complex to understand and utilize than is a river as receiving stream for liquid waste. The weather is both our friend and enemy. Perhaps, most of the time in most places, mother nature does a reasonable job of providing ventilation to carry away air contaminants. On the other hand, there are times at any location when the weather stagnates and, for all practical purposes, the air contaminants stay right where we put them in the air. Such a condition is called an inversion. When the air near the earth's surface is cooler than that above, it is more dense, and, thus, does not rise. The so-called normal condition of the atmosphere, especially at higher altitudes is just the reverse -- that is, the air above is colder than the air below. Thus we refer to an inverted condition. It is not really abnormal, however, since it is a natural phenomenon associated with heat transfer and solar radiation and with subsidence from high pressure areas. We are most concerned with this condition as it occurs in the lower few feet or several thousand feet above the earth's surface. It occurs more frequently in some areas than in others but can always be found at some time at any location. Even with some degree of ventilation, there are wind and weather conditions which move contaminants from large sources across great distances where they are returned to ground level in sufficient concentration to have an adverse effect. The plume carrying these contaminants may very well fumigate an area having a cluster of population or an area supporting agricultural activities. As the clusters of population become more numerous and expand -- such as the near-continuous urban sprawl of the Eastern Seaboard -- distance and weather become less of an ally.

Other wind conditions permit fumigation of the earth's surface near the air contaminant source with a resulting high contaminant concentration for a very short time. This is significant with certain contaminants such as sulphur dioxide which can have a severe effect on vegetation with only a short contact time. Water vapor content of the atmosphere is also important. One noticeable effect is the reduction in visibility resulting from the condensation of the water vapor on nuclei which are frequently man-made air contaminants.

It is true that, in a few extreme situations, the curtailment or stopping of industrial activity under severe weather conditions has helped. In the overall, however, this so-called meteorological control is of limited value unless we accept almost complete regimentation of our economic activities. For practical purposes, we can't control the weather. Our only option at this time is with respect to the control at the source of air contaminant emissions.

Fourth, let's look at technology. The biggest and most challenging problem today is to apply the technology which is known and has been demonstrated for the control of air pollution at its source. Irrespective of the fact that there are unknowns about air pollution and there are gaps in control technology, we do,

in fact, know a great deal about air pollution and we have a great many tools for its control. I do not mean to propose the uniform control or the application of uniform technology to a non-uniform problem -- but I do propose the application of technology where, when, and as needed at the earliest possible time. Where there are gaps in knowledge and technology, we must clearly define them, set priorities of action, and get on with closing these gaps.

In order to meet some of our major problems, massive changes from our old way of doing things will have to occur. Some of these are already happening. There are no easy black and white answers. We will not abruptly discard the motor vehicle simply because it is creating a large problem. Neither will we discard the use of fossil fuel. It is a resource we cannot throw away. The massive change now occurring is with respect to how we use what we already have. The motor vehicle, with the internal combustion engine, is likely to be with us for many years -- even though there is research and development on other types of motive power. The control of motor vehicle emissions is gaining substantially, even though the results, over a few short years, have been disappointing to some. We shouldn't expect total perfection in the first year, but we must insist that the control systems get better every year.

The combustion of fossil fuel presents a significant problem -- particularly in the east. Projections of power demand indicate that we will require both nuclear and fossil fuel for our future thermal power plants, together with our available hydroelectric capacity. Major strides are being made toward bringing low-sulphur fossil fuel to the areas of greatest need and there is reason for optimism in attaining desulfurization within economic practicality. Nuclear power may present a different set of problems, but, having started with this knowledge, the outlook is good. One of the more interesting air pollution problems associated with nuclear power may very well be the significant emission of water vapor to the atmosphere where cooling towers are used for waste heat dissipation. Important decisions will have to be made in each instance as to whether the heat will be dissipated to a water course or the atmosphere.

Future major changes may include those in energy source and motive power, the optimum use of mass transit, restructuring of the urban complex, etc. These will all have to be optimized in terms of economics and benefit.

Technology for the control of particulate matter is well advanced. We have the capability for very high efficiency in the removal of particles, especially those of larger size. We are not yet satisfied with our capability for the removal of the very small and submicron-size particles. A nuisance condition from particle deposition need no longer exist, nor is it necessary to have dense visible plumes. Particulate removal is generally accomplished with cyclones using the principle of centrifugal force for particle separation, by wet scrubbers of various types, by bag houses which filter the particles, and by electrostatic precipitators. The efficiencies are in approximately the order listed.

The control of gaseous materials is also well advanced. Wet scrubbing, adsorption, and high efficiency combustion are the most common techniques. Where very, very low concentrations can have an adverse effect, we will need continually-improved technology. An example is the problem of odor, such as from a kraft mill where even a significant reduction in the complex odor-producing compounds does not produce a proportionate reduction in the human response to the odor.

Changes in production processes and products are also a part of control technology. We may find it necessary to resort to this method more frequently in the future. In the control of solvent emissions, for example, much is being accomplished in California through changes in the chemical makeup of the product. This is particularly necessary since control at the point of use of many of the products is not practical.

In summary and conclusion, the following factors seem important:

1. It is essential that we recognize the fact that air pollution exists and its potential is growing. This is especially true in our large urban areas, but not exclusively so. There are many situations where large sources of air pollution exist in relatively remote or small-town areas. The effect on these small populations is just as important as on the mass populations insofar as the individual welfare is concerned.

2. We have the technology to control most of the gross sources of air pollution today and we should use that technology where and when needed now.

3. Where there are gaps in knowledge and technology, we must clearly define them, set priorities of action, and get on with closing these gaps.

4. The only practical action that can be taken now is control at the source of air pollution.

5. The very long-range considerations, such as the effect on weather on a global scale, the ultimate effect of urban air on large masses of population, and the finite description of economic effects and disbenefits, deserve appropriate and continuing research, but the lack of complete knowledge should in no way deter us from applying the knowledge we now have.

6. To live as a community, we must have laws. Voluntary action is to be supported and encouraged but, for the benefit of all, equitable and rational rules of the road, continually updated with new knowledge and administered with a high degree of capability and fairness, are essential to the orderly process of controlling air pollution.

This has been a very rudimentary review of air pollution. I hope it will provide the starting point for your discussions over the next few days. I am sure it is clear to you, as indicated by the very nature of this conference, that air, land and water pollution -- the unfortunate byproduct of our affluence -- must be controlled now before its disbenefits outweigh the benefits of our social, industrial and economic gains.

It has been my pleasure to be with you today and I do look forward to being with you for the balance of the conference. Thank you for the opportunity to be here.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"THE NATURE OF THE PROBLEM - - - WATER POLLUTION"

DR. ALBERT E. BERRY,
PRESIDENT,
THE CONSERVATION COUNCIL OF ONTARIO.

Pollution of man's environment is not new. It has existed, to some extent, since man first inhabited this land. It was not until the settlements along the nation's waterways grew into urban communities that this problem reached sufficient proportions to arouse public concern. For over half a century there has been an ebb and flow of interest in this situation. Now, at long last, there is a realization, greater than ever before, of the basic role and importance of our water resources.

Have we now reached the point where sustained action to protect our resources can be assured? Are we prepared to meet the challenge of new pollutants, of new demands on our resources, and a willingness to pay the price for a clean, healthy environment? We have come, it would seem, to a fork in the road of progress. Which path do we take? People confidently look through science to a future in which they can hope to become masters of their own destiny. Man's environment, with all the factors which play upon his welfare looms large in that destiny. But science alone cannot accomplish our hoped for objective, even though science is gaining momentum day by day, and its impact on all of us is more immediate than it has ever been. We shall have a better chance to survive and create that dream world if, in the years to come, we can produce more and better trained scientists, supplied with the best equipment, more engineers ready to nourish their art at the very frontiers of science; and if all this is combined intelligently with an aggressive public, fully informed and demanding in action. We cannot leave our future to the scientist alone. All must be a part.

What happens in the future depends on us. It has been well said by that eminent philosopher, Bertrand Russell, "that as a result of science the world of the future will be either very much better or much worse. You who are young will soon find out." Here then is a challenge for each to play his part and make a contribution to the world of tomorrow. Man's very survival depends on the wise use of his resources. It has been observed by one authority that the disaster which Americans must continually patrol against is the reckless and speedy consumption of our natural resources by our waste and profligacy. We could use up most of these resources and leave future generations comparatively destitute.

The prevention of such a catastrophe has come to be known as "conservation". Let it not be said that the individual is unable to play a part in this.

Man's contact with his environment is many-sided. Water, air, and soil are the most common ones, and these obviously must play an important role in his welfare and his safety. Life is close coordination with the environment. Even today's definition of environmental health says "anything which may have an adverse effect

of public health over what was formerly involved, in great measure, with the control of infectious diseases. It is a positive attitude on program for man's complete well-being.

It is clear that people are changed by technological changes. Technology is now giving us options, and will increasingly do so, to use our leisure time. Shall we use this freedom to choose in a profitable way to improve our status or will we waste it? We need to turn over our man-made environment into a teaching device. We can no longer depend on the relatively short exposure in the classroom. It will bear repeating that the wise use and management of natural resources can only be attained through an understanding of the basic processes related to water, soil, and the atmosphere. Man has now attained the ability to

alter drastically his environment and that of other organisms. Many of his activities already have impaired seriously his own environment and that of other living things. Water pollution and other changes, made in the interest of development and progress, ranks high in these detrimental effects.

Lessons from Past Experience

Can we derive some advantages from the experiences of the past? It would be a foolish man who would ignore these, even in this day of rapid change. Let us look at some of these events which have given rise to public reaction and have influenced behaviour.

In the early part of this century water pollution was considered chiefly in relation to typhoid fever outbreaks. The high prevalence and mortality from this disease aroused grave concern. But that was still regarded as local rather than provincial or national. In fact in 1909 when the Boundary Waters Treaty was under review between Canada and the United States it was recorded in the U. S. Senate that there was little possibility of pollution of boundary waters becoming a serious problem. The public could not well comprehend the significance of water pollution on such a large scale.

Yet it was only four years later that the Governments of Canada and the United States requested the International Joint Commission, created under the Treaty, to determine if the boundary waters were polluted so as to be injurious to public health and unfit for domestic use. This investigation revealed high bacteriological pollution. Recommendations for the correction of these conditions, resulting primarily from the discharge of domestic sewage, were neither ignored nor acted upon.

As water purification was extended, especially through the application of chlorination, typhoid fever outbreaks dwindled. The significance of pollution in drinking waters lost its public support, war and economic conditions added further argument for delay. The era of public indifference to water pollution had set in. Fear of disease was no longer the goad for attacking pollution. Public expenditures were demanded in other fields, more popular than waste treatment works.

The industrial developments which mushroomed after World War II brought with them the new problem of complex industrial wastes and congested urban dwelling. These new conditions, involving tastes in drinking water, physical degradation of the waters, and the fresh demand for abundant clean water for industry, growing municipalities and many other uses, gave a new focus to the value of water resources. In the last decade the appreciation of the value of these resources has grown tremendously. Public health and bacteriological parameters are no longer the complete yardsticks for quality. Water suitable for any and all uses must be the guiding principle. Many disciplines are now required in the management of water resources for these wider concepts of use.

The foregoing briefly summarizes the changing attitudes over the years towards water pollution. It must not be overlooked that public interest in the past has seldom manifested itself effectively until conditions became critical. The current means of communication and public information should enable a repetition of this procedure to be avoided. Do these lessons of the past teach us to act now as we stand at the fork in the road to progress?

The Water Pollution Problem

But this paper is presumed to deal with the water pollution problems of today: What are these problems and how are they to be overcome? What is our position at present? Are we losing or winning against water pollution? What can we anticipate for the future?

What is Water Pollution?

At the outset, there needs to be a clear understanding of what constitutes water pollution. Strange as it may seem this is not easy to define. One need only to look at the definitions given in various legislative enactments to see the wide divergence of thinking. Yet, we must know the rules of the game before we can be expected to play our part. All too often, the polluter or probably more correctly termed the user of the stream, claims he is not to blame. Others may regard pollution as something which to most people either doesn't exist or is of minor significance. It is for the technically trained and competent persons to agree on standards of water quality and to have these incorporated into legislation. In Ontario the definition is clear that pollution is anything which may impair or have an adverse effect on the quality of the water. It is not restricted to effects on public health. Gravel washing, the discharge of hot water, or the addition of color might come in this category. To make this definition more workable numerical figures are incorporated into standards or objectives.

In this province, the Ontario Water Resources Commission Act, first passed in 1956 and amended yearly since, is the legislation most directly applicable. It is broad in scope and must be recognized as modern as any to be found anywhere in the world. It deals with the overall management of water resources, a part of which is pollution control. Accordingly we can approach these existing problems on the basis that the legislation is intrinsically sound and capable of supplying the necessary background for action.

Stream Uses

There are oft-expressed misconceptions on the uses of a stream or other watercourse. It is clear that it must serve our domestic, industrial, agricultural, recreational, and other needs. But another use, and a perfectly legitimate one, is to carry away wastes. In the minds of some there seems to be an idea that no wastes should be allowed to enter a stream. This is totally unrealistic and impractical of attainment. Water which is devoid of dissolved materials is intolerable in nature because pure water will not support aquatic life. The obvious solution is to ensure that these wastes, as they reach the stream at any point, will not interfere with the reasonable use of that water by others. This is where standards of quality play an important role. These must be capable of ready interpretation and must be fair for all users.

Our modern concept of pollution control requires that no stream user has the right to cause injury to others, whether the others be municipalities, industries, agriculture, recreationists, or aquatic life and wildlife. This altruistic viewpoint has two requirements:

1. The right of the riparian owner to suitable quality in the water as it reaches him.

2. The obligation, on the part of anyone responsible for wastes, to treat or control these so they will not injure a downstream user.

This two-sided concept of water pollution must apply to all. But the actual requirements in this program will vary considerably as influenced by volume of diluting water, uses made of it, and the nature of the wastes. The criterion is thus to ensure that any polluting substance will be below a specified level. This will be determined by laboratory tests.

Every watercourse has a certain capacity to receive wastes within the quality limits. Fortunately streams have marked recuperative ability to break-down most wastes and render them harmless, but some of the modern complex pollutants are slow to degrade. Insecticides and pesticides are examples. So was the old form of detergent. Regardless of the substance and the volume of flow of the stream the amount must be kept within prescribed limits.

Here then is the objective we must set for ourselves in the control of water pollution. The watercourses are for all uses by all persons, but no one has the right to interfere with the use of those waters by others. This has many difficulties on a small stream serving as an outlet for several communities.

What Has Been Accomplished?

There is obviously a good deal of public confusion about what has been and is being accomplished today in water pollution. This is a world-wide problem, and it is being attacked on many fronts. Since this conference is for Ontario alone, it is well to consider what has been accomplished here. The problem or difficulty is constantly compounded by the increase in population, concentration in urban centres, and the growth of industry. All these tend to add more wastes, with the discharges at a limited number of points instead of being diffused. Accomplishment must be measured by the construction of waste treatment facilities and by the assessment of water quality. There is ample evidence from the records that in recent years, for ten or more years, a great deal has been done in this province.

Where Do We Stand Today?

In spite of these accomplishments, and all the planning that goes with them, we are most concerned about our present position. Have we reached the desired objective, or what more is to be done? What also can be done to meet the problems which are certain to arise in the future from industry and communities?

Recently the comment was expressed by a foremost authority that in his opinion the situation in respect to water pollution was getting worse. He was speaking of world conditions. This does not appear to be so in Ontario. At the same time it is necessary to emphasize that problems, and difficult ones, still exist here. In fact, to be realistic we must expect that pollution problems will always be with us. This does not preclude the maintenance of that reasonable standard of water quality as we may see fit to set up.

Why Are We In This Position?

If polluting man's environment has worsened over many years why has it been allowed to do so? This is a question which many find difficult to understand. We should recognize that all the activities of man produce wastes of some kind. Are human beings less disposed than animals to protect their environment against these wastes? It would seem to be the case. Why have so many municipalities, even large cities, turned away from building sewage purification plants? Why is the largest city in Canada still discharging all its sewage untreated into the river? This negligence has persisted in spite of strong warnings, urgings, and endeavors of senior levels of governments.

There seems one predominant reason -- lack of interest on the part of the public. It is true that the war and economic conditions were also convenient factors, but other measures, involving large expenditures, were undertaken. Sewage had no appeal so long as it moved elsewhere from the front door.

What Are The Problems?

If we have been slow to meet our obligations in protecting our environment, and if we still have much to do, what are the present day problems that hold us back? It is well that these be examined critically. If we are now to succeed, we must know those factors that act as a brake on our efforts. There are still many of these.

1. Public Attitude

It has been seen how public attitude influences our actions and especially our expenditure of public funds. At present, the interest of the public is most encouraging, but will this continue until these measures are well advanced? There will need to be strong leadership to keep the movement in the right direction.

2. Public Information is a very necessary part of the program of action. Our present media of communication make it possible to convey information very quickly. The great danger in this is that the wrong information may be given, and the resulting action will be disappointing. There is yet no consistent means being used to ensure that adequate and reliable information reaches the public, and especially to those who must make decisions. Conferences of this kind will be helpful, but if these efforts are to bear fruit there will be need for concerted and continuous action on the parts of governments and voluntary agencies. This is one of the problems of today, and we need to find an early answer and a better one.

3. Urbanization and Industrialization are two factors that go hand in hand to create a major problem. Yet we cannot expect this to be otherwise. Industrial production is so much an essential part of our standard of living that we must look for measures that will correct the deficiencies. In the case of water pollution it should be no more difficult, and in many instances less difficult, to treat these wastes by acting jointly rather than separately.

4. Industrial Wastes and Municipal Co-operation

Many of the present unsolved problems relate to the treatment of industrial wastes. Some of these are difficult in that they do not respond

to the conventional methods of sewage treatment. Where these wastes can be mixed with municipal wastewaters their separate effects are often greatly reduced. Furthermore most industries are not specialists and do not desire to be, in the treatment of wastes.

There seems good reason today for municipal bodies to assume greater responsibilities for the treatment of wastes from industries within their borders. This should be considered as a municipal duty. The cost factor need not be a deterrent if arrangements are made to have these wastes treated at cost. Since industry pays large amounts in municipal taxes they have reason to expect a service of this kind. Looking at it from the standpoint of efficiency in results there is much to commend this practice of joint effort in waste treatment.

5. Cost of Treatment

The cost of waste treatment can never be given second rating, although in comparison with many other public activities it is not in an unfavorable position. One of the current problems with industrial wastes is undoubtedly the cost. This is especially true where the wastes are strong or do not react readily to treatment. Again, if the operations are seasonal, the capital costs to be spread over a few months' activities rather than all year will be high. Combined with this is so often the need for a high degree of treatment because of the low flow seasonally in the receiving stream. Many of the watercourses of southern Ontario are so low in flow when most needed that they can carry only a small pollutional load. Must these conditions restrict the location of industries to large centres unless the smaller places are prepared to assume greater responsibilities in the treatment of the wastes? This appears to be the trend.

6. New Pollutants

We must expect, as we have in the past, that there will continue to be new pollutants among the wastes from modern living. Industry is much sought after, but if this is desired there must be a recognition of the wastes resulting from these operations and the feasibility of treating them successfully. Here is a problem which will require aggressive and co-operative action. Research will also be necessary.

7. Regional Solutions

While a good eal has already been done in considering waste treatment facilities for regions rather than by municipal boundaries this is still an acute problem. If municipalities cannot combine voluntarily for this program there is the very excellent arrangement for having the O.W.R.C. provide the service on a rental basis. The questionable luxury of having these plants built in proximity to one another to serve individual municipalities cannot be justified on a cost basis or efficiency in results.

8. Research Needs

Much has been said about the need for research in this field and of the inadequacy of the present programs. There are many facets of this problem which call for investigation. Here, surely is a field for the federal government. The results will benefit all Canada. Coordination of research efforts is also an urgent matter if we are to conserve our efforts and costs. These research studies must not only be directed to the development of new and more effective waste treatment processes but also to more economical measures. There is a real need in this today.

9. Agricultural Wastes

The problems of municipal and industrial wastes have been stressed herein, but what about agriculture? Two factors come to the fore at once. One must be the objection which the agriculturist finds to pollution of the stream from another source. This can have a damaging effect on his operations. The second problem is the waste from the farm itself. Agriculture is approaching more and more to industrial operations. The runoff from the land of wastes of high organic content, and the escape of chemical products for pesticides and herbicides open up a new challenge. There is need for a more active program of assistance to the farmer in the solution of this problem.

10. Higher Degrees of Treatment

Another current problem is aligned with the need for higher degrees of waste treatment, as well as the removal of certain other constituents. This may be illustrated by a small community with medium treatment and discharge of the effluent to a small stream. As the population grows or industry comes, the degree of treatment must be stepped up. The cost, for both capital and operation will be greater. The problem is further emphasized by the need to remove nutrients from the municipal wastes. The much talked about condition in Lake Erie calls for the reduction of nutrients, especially phosphates and nitrates. These are inadequately removed by conventional treatment works. Here is a new problem which may involve all wastes including municipal, agriculture and industry.

11. Solid Wastes

All too frequently the relationship between liquid and solid wastes has been overlooked. Garbage and all kinds of solid refuse are increasing at a rapid rate. Where can these be placed? Land for sanitary landfill is fast being used up. Care must be exercised in the selection of the site to ensure that the leachings therefrom will not pollute a watercourse or the ground waters. This is equal to or more important than any nuisance which may result at the site of the operations. There is an unwillingness on the part of municipalities to accept wastes from other municipalities.

12. Administration

The previously listed problems have been mostly concerned with the technical and physical difficulties to be overcome. What about the administration of these programs? Ontario is fortunate in having good basic legislation on water resource management yet complications do arise. Three levels of government are involved to some extent. It must be confusing at times on where are the lines of delineation among them. The same must be said about the relationships among the departments or branches of a single government; can this be clarified and each know exactly what is required? Probably it is too much to expect that this will ever be completely effective, but it is a problem which calls for action.

Similarly, financing of these measures is related to the administrative and legal side. Federal assistance in municipal sewage treatment costs have done much to ease the burden, but that industry which does not use the public sewers does not come within this orbit. The problem of financial assistance is complex, and it is difficult to assess the amount and from what sources this should come.

Summary

The foregoing is an attempt to review some of the problems and difficulties associated with water pollution. No effort has been made to provide detailed remedial measures. The discussions of this conference will no doubt examine these problems as well as many more. Only the surface of the field has been examined in this paper. Many more problems do exist and call for solutions. These matters are urgent: Tomorrow is today, and its problems are hurtling upon us. We need to solve those of today without delay and be prepared to meet those of the future.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"THE NATURE OF THE PROBLEM
- - - SOIL POLLUTION"

PROF. L. R. WEBBER,
DEPARTMENT OF SOIL SCIENCES,
UNIVERSITY OF GUELPH.

Agricultural science, especially the sciences associated with soils, crops and animals, is based on a very simple principle: if the environment is favorable our living resources, including soil, will renew and perpetuate themselves. Today, the favourable environment of some soils and the health of humans and animals are threatened by pollution from: (1) domestic and industrial wastes; (2) a rapidly changing agricultural technology requiring an intensive use of agricultural chemicals; and (3) the trend to raise livestock under high-density confinement housing. The ideal pollution control implies no impairment of the natural environment. However, it is a basic principle that: the consumption of every resource leads inevitably to the discharge of a waste, and that abnormally high concentrations of waste have a detrimental effect upon the environment of soils, crops, animals, and humans.

As of now, soil pollution* is not widespread but many people are concerned about the slow, persistent build-up of toxic compounds in soil, the large acreages of land that are required to bury and hide from sight vast mountains of waste and at the same time an affluent society demands more and more land for living, recreation, and all those activities associated with a population enjoying the world's highest standard of living.

A concern for the environment of our soil resource is natural; soil is the essential link in the food chain of humans, animals and plants.

Soil Properties Influencing the Fate of Pollutants

The problems of soil pollution differ in many respects from those of water or air pollution. Soil can accept and decompose, without detrimental effects on the environment, vast quantities of wastes and pollutants of many kinds. The ultimate fate of organic and inorganic chemicals and biological substances when added to soil depends upon the physical, chemical and biological environment within the soil.

Normally, organic matter represents < 1.0 to 5.0 per cent by weight of a mineral soil, but because of its colloidal nature, it is the site of many physical and chemical reactions. Soil organic matter presents an enormous surface area (500 to 800 m^2 per g.) and accounts for 30 to 60 per cent of the exchange capacity of the soil.

The porous matrix of a soil is determined by the structure and arrangement of the soil solids (silica, silicates, various oxides, carbonates, phosphates and many others). Soil pores occur inside and among individual soil aggregates. The total pore space, occupied by air and water, varies from 35 to 65 per cent of the total soil volume. The volume of large pores determines the extent of soil aeration and water movement, significant factors in the degradation of pollutants.

Within a porous medium, such as soil the movement of chemical substances takes place by diffusion or convection in either the liquid or vapour phases, diffusive movement occurs with variations in concentrations with position in the soil; convective (mass) flow of chemicals normally follows the mass flow of soil water.

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* A soil pollutant is any substance which, when added to the soil, lowers the yield or quality of farm products, impairs the health of animals or humans, or which may contribute to subsequent air or water pollution.

Soil microorganisms are not distributed uniformly throughout the various layers; they occur most abundantly in the surface layer where the conditions for growth -- warmth, moisture, food supply and organic matter -- are most favorable. The nutritional requirements of soil microorganisms are similar to the higher plants. Their dry weights range from 50 to 1300 pounds per acre of surface soil of which 130 pounds occur as nitrogen in complex forms.

Bacteria, actinomycetes, and fungi are potent agents of decomposition. They are indispensable: (1) in the mineralization of plant and animal residues, (2) in increasing the availability to higher plants of minerals in inorganic combinations, and (3) as an essential activity in the nitrogen cycle.

Existing and Potential Pollution Problems

Soil is one of the three natural reservoirs where potentially dangerous pollutants can accumulate. Pollutants may be added directly to soil by man in his efforts to control a multitude of pests and to dispose of unwanted unsightly wastes. Harmful pollutants may reach the soil from decaying vegetation that had been treated with a variety of biocides or from the air by industrial activity or by atomic explosions.

Radionuclide Fallout

Scientists have identified about 200 isotopes of 35 elements from nuclear explosions and fallout. We are primarily concerned with two radioactive elements that can accumulate in soil -- strontium-90 (Sr-90) with a half-life of 28 years and cesium-137 (Cs-137) with a half-life of about 30 years.

Sr-90 is a recent soil constituent following the atmospheric testing of nuclear weapons. Once the element reaches the soil it is held securely in the surface few inches of soil, primarily by soil organic matter and the clay fraction. Sr-90 would be carried to water supplies only by uncontrolled soil erosion. There is no evidence that Sr-90 moves under grass or forest cover or that it accumulates in drainage ways. Sr-90 has received more attention than other nuclides because of its occurrence in milk and its deposition in bone tissue.

Radioactive cesium (Cs-137) is held by a soil but is available to plants and presents a minor health hazard.

The present monitoring program of the United States in cooperation with Canada indicates that the levels of radionuclides must be raised enormously before significant hazards would exist. If the atmospheric testing of nuclear weapons is eliminated, the levels of radionuclides in soils will continue to decrease.

Pesticides

Man's ability to survive, clothe and feed himself is directly related to his technology that enables him to understand, control, or manipulate his environment. If we are to survive, it is mandatory that man maintain an ecological balance of nature in his favour.

A new method of monitoring pesticide residues in the Canadian diet was introduced by the Food and Drug Directorate in 1963. The investigators examined over 3,300 samples of raw food, mostly from areas where residues were expected to occur. Only 6 per cent of the residues were considered to be excessive. During 1963 and 1964, analyses were made of 60 selected restaurant meals including the individual components of the meals. The study indicated that residues were detected in 36 per cent of the food but at only a fraction of the approved tolerances[1].

Results from investigations by the U. S. Food and Drug Administration showed that very minute residue levels of some pesticides were detectable in the American food supply by the highly sensitive analytical methods[2]. The levels were generally less than 1 per cent of the safe legal tolerances. Many of the commonly used pesticides were not found at all.

California has about one-fifteenth of all land cultivated in the U. S. and uses one-fifth of all pesticides[3]. In only one instance, an estuary in the heart of the world's most intensely farmed area, was there a residue in fish which exceeded the tolerance levels. Pesticide analyses were performed on sediment samples taken from 126 places in the Mississippi River between Tennessee and New Orleans. These analyses indicated only two areas of significant contamination -- one in association with manufacturing operations and the other in association with a group of pesticide formulating plants[4].

Generally, pesticides that reach the soil tend to be fixed immediately in an inactive form, or to be destroyed within a few months. A serious problem may develop with the long continued use of pesticides resistant to biological degradation. Even though a soil reduces the availability of pesticides, they may enter the food chain of wildlife that lives on the soil fauna.

We admit there are instances where wildlife has been a victim, often through man's ignorance in the use of pesticides and through the biological concentration in the food chain. We are also convinced that research will evolve at an accelerated rate, specific compounds for a specific purpose and having done their intended job will be degraded to harmless levels or compounds in a soil.

To protect our environment from the potential hazards of pesticides, we need to know in a very precise manner the absorption, movement, behaviour and fate of pesticides in soil, water, and plants. More information is required on the biological accumulation in organisms and the long-term cumulative effects on human health. Eventually we shall make specific recommendations of rates, time, and methods of application of pesticides with a background knowledge of soil properties and the target pest.

Solid Wastes

The disposal of solid wastes from the home and from industry is frequently one of the major causes of environmental pollution. It is virtually impossible to separate disposal problems as related to soil, air and water. The

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(1) Hurtig, H. and C. R. Harris (1966). Nature and sources of pollution by pesticides. Background paper A2-4. Pollution and Our Environment. Montreal. Oct. 31 to Nov. 4.

(2) Pesticides and their effects in soil and water. (1966). A.S.A. Spec. Pub. 8, p. 7.

(3) Ibid, p. 13.

(4) Ibid, p. 142-143.

disposal of solid wastes by landfill operations must be considered in terms of land pollution.

Sanitary landfilling is perhaps the least expensive disposal method in use today, if you make a short-term appraisal. Too often, "Sanitary landfills" are open dumps -- near-ideal conditions for flies, rats and other disease-carrying pests as well as smoke and foul odors.

It is a well-established fact that decomposition takes place in the dumps. Products of this decomposition are potential hazards to the pollution of soil water and groundwater. To avoid this hazard, the selection of sites must be based on a detailed and careful appraisal of soil type and geological formations. It is essential that the site be entirely separated from any source of groundwater.

We see high-temperature composting of most solid wastes including household garbage and sewage sludge as an acceptable means of ultimate disposal. At the moment, the greater use of composting techniques is delayed until the economics of the procedure have been detailed. Agricultural land would profit by the use of composted wastes provided the product is available at no cost. A farmer realizes that the compost has no fertilizer value -- it is largely organic in nature and to maintain a proper carbon-nitrogen ratio in the soil, he faces an expenditure in more chemical fertilizers.

We urge municipalities to investigate the future of composting as a solution to waste management. The agricultural industry can be persuaded to use the by-product. Relatively little research is needed to answer the problems in using a compost produced by a high-temperature process.

Problems of waste management and control are aggravated by the complexity and fragmentation of our larger city governments, the surrounding urban development, and the outer ring of intensively used agricultural land or land held by speculators.

Any material becomes a discard when we decide it has no further value or use to us. A suggestion that we invest more money for disposal is not favorably received regardless of our objections to others polluting the soil, air, and water.

We have the technology to advance waste management beyond the garbage pail and home incinerator level. It would appear that society will be motivated to authorize better waste management practices only when public health is threatened.

Septic Tank Effluents

The effluents from septic tanks are discharged into soil by means of field tiles. Under proper soil conditions -- depth, texture, drainage and absence of impervious strata -- bacterial action renovates the waste without causing soil pollution or health hazards. It is necessary that aerobic conditions exist in a soil if the effluent is to be properly treated. Obviously the renovating capacity of a soil increases with the depth of a well-drained soil.

It is an established fact that coarse sands and gravelly soils serve only as mechanical filters and permit contaminated water to move through. The percola-

tion rate of clay soils is normally too slow for adequate disposal systems. A soil must retain the effluent long enough to permit soil microorganisms to complete the microbial decomposition of the waste, to facilitate the adsorption by the soil of specific chemical ions and the utilization by plants of many compounds.

The extensive use of phosphate-base detergents in soaps (2.5 pounds per capita per year) tends to impair soil permeability, induce soil clogging, and generally reduce the effectiveness of soil as a disposal medium for septic tank effluents.

The excessive enrichment of ground and surface waters has been erroneously attributed to the agricultural industry. Studies in Southern Ontario show conclusively that domestic sewage contributes more phosphorus to surface waters than the drainage from agricultural land [1, 2]. Annual yields of phosphorus varied between 100 pounds per square mile from an agricultural watershed near Toronto and 8,000 pounds per square mile from a heavily urbanized area. Data from one well-service watershed indicated that approximately 90 per cent of the yield of phosphorus was directed through the treatment facility [1]. Phosphorus contributions to the Grand River from rural areas, approximately 36 pounds of phosphorus per square mile per year, do not appear significant when compared with the yearly per capita contribution of 2.5 pounds of phosphorus from sewage effluents[2].

Overloaded and poorly designed septic systems and particularly the installation in wholly unacceptable soil conditions have lead to soil pollution and outbreaks of infectious human diseases.

The phosphate content of water appears to be a major factor in lake pollution. Sources of plant nutrients are principally human sewage, industrial wastes, and phosphate-rich detergents[3].

To solve the problems associated with the proper disposal of human sewage, we need only apply intelligently the technology now available and enforce the Public Health Act.

Agricultural Activities and Environment Pollution

Agriculture has done an outstanding job in increasing farm production and providing the country with adequate food at a reasonable cost. The number of farm workers continues to decrease each year; the acreage of improved land per person has decreased about 50 per cent in the last 25 years. These significant changes dictate that our farmers are compelled to use management practices which will sustain and even enhance the present rate of waste production and the accompanying hazard of environmental pollution.

It is inevitable that as agriculture becomes more intensive, utilizes more and more pesticides, fertilizers and control agents, the pollution hazard in-

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(1) Owen, G.E. and M. G. Johnson. (1966) Significance of some factors affecting yields of phosphorus from several Lake Ontario Watersheds. Univ. of Mich., Great Lakes Research. Pub. 15.

(2) Missingham, G. A. (1967) Occurrence of phosphates in surface waters and some related problems. J. Amer. Water Works Assoc. 183-211.

(3) Eutrophication. Science 158: 278-282. 1967.

creases. There will be a corresponding increase in wastes that have become unnecessary to the economical production of our food supplies. Agricultural scientists are particularly active in researching the necessary control measures to minimize environmental pollution. We see the major problems as:

1. odor and noise control, particularly in the urban-rural fringe area, and where livestock is reared under high-density confinement housing.

2. minimizing the losses of fertilizing elements particularly nitrogen by leaching and erosion and phosphorus by erosion.

3. the disposal and utilization of agricultural wastes which are dominantly putrescible easily degraded organic materials.

The Odor Problem

Obnoxious odors develop when organic material undergoes anaerobic decomposition. The offensive odors usually contain compounds of sulphur, particularly hydrogen sulphide and numerous other gases with unique properties injurious to the health of humans and animals. Intensive research at the University of Guelph and with cooperating farmers is based on a very simple principle: reverse the anaerobic decomposition making it aerobic by the incorporation of air to increase the oxygen content of the waste. Our major activity is to develop new mechanical processes or modify existing techniques that would increase the efficiency of incorporating more oxygen in the waste. Aerobic digestion of municipal wastes is an accepted and successful procedure because the wastes are highly diluted. An enterprise involving 30,000 layers or 2,000 hogs -- this is a small farming operation -- has a waste disposal problem equivalent to a town of 4,000 people. We are confident that our research staff will develop mechanical devices that aerate the concentrated waste, reduce the odor problem, and provide a waste that may be spread on land with a minimum hazard to environmental pollution.

Losses of Nitrogen

In a soil system, we are primarily interested in the ionic forms of nitrogen, NH_4^+-, NO_2^--, and NO_3^--N. Ammonium NH_4-N and ammonia NH_3 forms are normally sorbed by the clay and organic fractions of a soil. In general, NH_3 will react with the soil organic matter whereas NH_4-N will be adsorbed on the exchange complex or securely fixed by the inorganic fraction in soils. NH_4-ions on the exchange complex are easily removed and by a biological transformation (nitrification) occur as NO_2^-- or NO_3^--N. It is extremely important to know and evaluate the effects of the naturally occurring organic and mineral fractions on the fate and behaviour of applied organic or ammonia forms of nitrogenous fertilizers.

Other reactions occur which render inorganic nitrogen immobile by transforming it to an organic form; mineralization releases nitrogen in a form available to plants and in a form free to move with the soil water. Denitrification, usually an anaerobic process, involves the biological reduction of NO_3^-- and NO_2^--N to the gaseous forms.

The movement of NO_3^--N to the groundwater usually occurs during late fall, winter or early spring when the soil conditions discourage biological activity and soil moisture is moving deeper into the soil.

Losses of Phosphorus

Any discussion or reference to phosphorus in agriculture uncovers a group of uninformed, highly emotional anti-pollutionists who level ridiculous charges against the agricultural industry. Their knowledge is confined to such facts as: agriculture is the largest user of phosphorus compounds; phosphate fertilizers when added to a soil become virtually insoluble and are chemically fixed; farmers realize only 10 to 30 per cent recovery of applied phosphorus and finally, phosphorus is a key element in lake eutrophication. Soil scientists concur.

The illogical reasoning of the anti-phosphorus pollutors proceeds to the point where they become hopelessly ensnared: if phosphorus becomes insoluble, a farmer adds an ineffective chemical element, therefore he should discontinue the practice; the excess phosphorus in a soil reaches the ground water and our lakes but they fail to tell you how, even though it is insoluble. They maintain that soil erosion is universally at catastrophic levels.

The overwhelming evidence absolves agriculture as a major source of the pollutant phosphorus. We have cited intensive research under septic tank disposal, which showed that a major source of phosphorus in our lakes was human sewage. The concentration of phosphorus in soil leachates rarely exceeds 0.1 ppm or 1.0 pound in 10 million pounds of water, equivalent to 44 inches of water over an acre*. The fixation and precipitation processes are recognized and accepted as accounting for the insignificant quantities of phosphorus in drainage water from agricultural land.

We are concerned about the phosphorus that is removed from agricultural land by the soil erosion process. While tons of soil may be shifted by water erosion, no estimate can be made of the small percentage that actually reaches a water supply, such as streams, rivers, or lakes. Harlow[1] concluded that land runoff played a minor role (6 per cent) in the contribution of nitrogen and phosphorus to Lake Erie. Studies on watersheds near Toronto and in the Grand River Valley show that the losses of phosphorus from predominantly urban watersheds were as much as 50 times greater than the loss from farm land.

Disposal and Utilization of Agricultural Wastes

Where livestock, including poultry, is reared under high-density confinement housing, the disposal of large volumes of manure is a management problem of growing importance. The manure must be moved from the housing area. The waste generated by the livestock population in Southern Ontario creates a disposal problem equivalent to a human population of 45 to 50 million people.

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* one acre-inch = 3630 ft^3 water = 22,600 pounds
one million pounds of water in 4.4 acre-inches.

(1) Harlow, George L. (1966) Major sources of nutrients for algal growth in Western Lake Erie. Univ. of Mich., Great Lakes Res. Div. Pub. 15: 389-394.

About a year ago, a committee on the utilization of animal wastes was formed at the University of Guelph. The members of the committee include personnel from Guelph (Agriculture and Veterinary Science), University of Toronto, Ontario Water Resources Commission, Ontario Department of Health, and the Ontario Department of Agriculture and Food.

The approach and philosophy underlying the current and projected research of this committee may be stated as: in the scheme of life almost all the compounds that come from a living process must be returned to the cycle to build, repair, or provide energy for other forms of life. Thus, livestock manures should be re-cycled by returning the waste to the land and by growing appropriate crops for efficient utilization of the by-product.

The treatment and the disposal of animal wastes are complicated problems for agriculture. Compared with municipal sewage, animal wastes are highly concentrated. It is not economically feasible for a farmer to dilute, lagoon, and remove the chemical elements before discharging the waste to a waterway. At Guelph, our research is oriented to the approach that land disposal is the most feasible means of disposal.

The committee on the Utilization of Animal Wastes released a publication which detailed the land requirements for the utilization of animal wastes in crop production. Throughout the publication, emphasis is placed on the nitrogen economy; phosphorus and potassium are not considered as potential pollutants. Research at Guelph has shown that medium-textured, well drained soils will biodegrade 250 to 300 pounds of BOD per acre per day during the growing season. In terms of nitrogen we recommend a maximum of 300 pounds of nitrogen per acre on corn or hay-pasture mixtures. It has been established that this quantity of nitrogen will be used by crops and not contaminate the ground water.

As the trend to use liquid manure handling systems increases, the danger of water pollution by erosion during the winter or early spring decreases. In a liquid form the waste enters the soil and is immobilized.

Conclusions

To a lesser degree, soils contribute to environmental pollution; to a greater degree soils are the victims of pollution by man. As of now, soil pollution hazards exist largely because of the almost-frantic efforts of man to get rid of his wastes. Soils and the groundwaters have been polluted by inadequate disposal systems for human sewage, industrial wastes, and in isolated instances by livestock reared under high-density housing. Agriculture is not guilty of the gross pollution of water by phosphorus. Situations exist where an agricultural activity may have contributed to above-normal levels of nitrogen in the groundwater.

There are townships considering legislation that would require the exclusion of all livestock rearing enterprises. Generally, these are the communities where the farm operation was in the country and the absence of land-use zoning programs, ineffective municipal ordinances, and our society's desire to live in suburbia, have threatened the existence of the farm which was established first but had no protection from being engulfed by suburbia.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"OUR MODERN ECONOMY"

MR. L. F. WILLS,
CHAIRMAN, ONTARIO DIVISION,
THE CANADIAN MANUFACTURERS' ASSOCIATION
AND
PRESIDENT, HONEYWELL CONTROLS LIMITED.

To some people another word for pollution is waste. For waste, read sewage and that leads me to wonder if it is appropriate to have a speaker on this subject in a luncheon setting. That's quite a sweeping generalization -- and a deliberate one. I made it to emphasize that no field attracts more sweeping generalizations than pollution. Nor, more recently, a tendency to hysteria.

I hope, most sincerely, that your conference will be eminently successful in achieving its objective of promoting better public understanding of the nature and scope of the pollution problem. More important I hope, because of this conference, the residents of Ontario will become better informed on the complexities faced by all levels of government and by industry in finding practical solutions. Let us pray you succeed in establishing attitudes which pay no heed to sweeping generalizations and pat solutions which cause confusion and seem to stampede governments into actions of expediency.

In saying this I am not suggesting that the conference turn into an exercise in brushing the problem under the rug. Far from it. On the contrary I would like to congratulate all those responsible for arranging this gathering for the specific purpose of exposing the situation to public gaze and to promote informed discussion.

From that bouquet let me move to a brickbat. That is the criticism of government for not moving more quickly to direct the control of all forms of pollution. In 1958 The Canadian Manufacturers' Association urged the Government of Ontario to take over the responsibility of air pollution control measures and to implement them on an area basis.

Apart from a preliminary step in 1963, action along these lines was not taken until this year -- nine solid years after we first made our suggestions to Queen's Park! What an opportunity for a brickbat! What an invitation for a flood of criticism from the impatient or uninformed! But I am not here today to deliver any such criticism on behalf of industry because we in industry are not completely wonderful and we understand the complexity of the problem and have an appreciation of the other fellow's difficulties. In this case the other fellow is the Government of Ontario.

But I did want to get that part of the record absolutely straight. I know it is not understood that some nine years ago we in industry registered with the authorities that we were ready for more effective control of pollution. We recognized this as a special case where we were not crying for less government involvement. We asked for more.

While the government made its preparations for the new Air Pollution Control Act, industry did not stand still. Instead of indulging in carping, individual companies have taken giant strides to mend their own pollution fences. I will not catalogue them all but remind you, by way of example, that one company -- just one company -- has been spending over one million dollars a year in air cleaning devices on its smoke stacks.

Control measures have become an integral part of all plans for new plants, not just to control pollution but to try and avoid creating it in the first place. One company has isolated the cost of pollution control as five to ten per cent of the cost of a new plant or facility. It accepts this cost as an integral part of its planning. The same holds true for many other manufacturing enterprises.

Let me say, before I go any further, the manufacturing industry, as an industry, has no apology to make for its part in the overall pollution picture. In fact, as I have mentioned, it was years ahead of those who only now are making the most public noise about it.

Another example: Pollution conditions would be 100 per cent worse than they are now in the Sarnia area if the major industries there had not taken action of their own -- 15 years ago -- in 1952, to control pollution. I say that because industrial activity has doubled there in the past ten years, yet pollution has not increased significantly in the same period. In other words, without the direct voluntary efforts of Sarnia's own industries, things would be 100 per cent worse than they are.

The unfortunate thing is that industry does not get credit for what it has done. Of course much more must be done. This is now coming about through legislation which will apply right across the province. I am sure the government is in no doubt that it has the backing of manufacturers in its new program. If it has any doubts, or if anyone here has any doubts, let me put them to rest once and for all. The manufacturers of this province asked for more stringent controls on a province-wide basis and they will lend every effort to the success of the new legislation. Let there be no doubts about that.

May I also remark that in Ontario we now have more progressive legislation, for all forms of pollution, than in any other province or, indeed, in any of the United States.

There is no questioning the magnitude of the pollution problem. Let's look at a few measures of its size. I understand that complete separation of sanitary and storm sewers in a large city would cost $10 million per square mile. Put another way, that is $1,000 per family or, for a city the size of Winnipeg, $2 billion. Spreading costs of this size over a ten-year period would add an average of $100 annually in property taxes to every home. I don't need to tell you how unpopular that would be with the municipal taxpayer. Remember, too, it is the cost for just one form of municipal pollution. Nevertheless, it is a cost which citizens may have to face just as industry faces its own expenses of pollution control.

Another measure of costs: the federal investigation of pollution of the great lakes will continue indefinitely and it is estimated that the annual price tag -- note that, annually -- will reach $5 million within three or four years.

Those are just some yardsticks of the size of the problem and the price of the solution.

Another measure is the complexity of the technical knowledge involved. One of the plants in Hamilton recently installed a new process to re-use an acid solution instead of dumping it in the lake. The point here is that the process which permits this type of control was just not available previously.

While referring to Hamilton, let me mention another example from the ambitious city. A plant there has a control process which sounds as if it came from science fiction. Phenols are eliminated by a specially developed bacteria which can survive only by eating the normally poisonous phenols.

Why has the problem been allowed to develop to such proportions?

There has been public indifference. Governments may not have moved as quickly as they should. Many industries have been reluctant to act quickly. This is a situation which involves all parts of our modern society.

A phenomena of the times is the dissent with and criticism of the social, business and governmental structures of the day.

Educational institutions criticize the policies of business leaders.

Many people criticize the conduct of the Asian war.

The Hippie criticizes the social order.

Provinces criticize each other -- and everyone criticizes government.

Not all of this is bad. It is wise to establish responsibility and to define the areas of responsibility.

All criticism, good and bad, exerts influence for change and this is in the interests of progress.

In the matter of pollution -- air, water and soil -- one detects an intensity going beyond the bounds of constructive criticism. A bitterness and vindictiveness of an emotional nature.

Pollution has been with us for some years. We didn't get there overnight. It is just that in the recent past we have become aware of, and have come to appreciate the magnitude and importance of the problem.

Certainly industry is a contributor to the pollution problem. So too is the car manufacturer and car driver -- public transportation bodies -- car, bus and train.

Municipalities are prime offenders as are other forms of government enterprises.

Citizens are pollutors of soil and water if not of air.

If all parts have been guilty, to some degree, then I object strenuously to those who cry: "Let's close industry down until it does not cause pollution." Would the same people ask that all cars, trucks and buses be banned until a totally effective device can be installed on vehicles? Would the same people like to close down all coal burning power plants, apartment buildings, office buildings and municipal incinerators? Would they stop trains and banish ships from the Seaway?

Let us not imagine if everything which causes pollution in Canada was closed down until the perfect controls were developed that the rest of the world would wait while we put our house in order. We must act just as quickly as is humanly possible. Sacrifices will have to be made but, as far as possible, we must follow practical steps to sane solutions. The complexities are great, the solutions are not easy, but it will serve us all best if our approach to the pollution problem is devoid of emotional excesses and recriminations. Let us get on

with solutions to our great problem -- sincerely and objectively, acknowledging that we have been unwise and unthinking -- and devote our energies to corrective measures. Government, the public and industry. Let us spend no further time hurling brickbats over inaction in the past, but let us also recognize that there has been more progress than is generally admitted.

Two final points before I turn from the pollution scene to the more general heading "Our Modern Economy" to which I was invited to address my remarks.

I would like to see recognition of two fundamentals -- one: Industry is not the prime culprit on the pollution scene but has probably made the most progress in meeting its responsibilities.

Two: People must realize they cannot expect rural air and water in urban areas and, with Canada's growing drift to the cities, this may be worse before it is better, despite new and strenuous efforts to provide cleaner air and water.

Misrepresentations about business and our competitive system are not confined to the subject of pollution. Many of these can be overcome by business as a whole giving more positive leadership where some of the great social issues of the day are concerned. Business already devotes a great deal of energy to such public issues as education and social services.

It must not be forgotten that running a successful enterprise is the primary social responsibility of any business. It cannot serve society at all if it does not survive and prosper. The primary concern of an enterprise is that it should endure. For it is the successful company which provides the job opportunities, which pays the lion's share of all taxes to support such sound welfare benefits as old-age pensions and family allowances and which supports hospital, university and similar funds.

While it is constantly meeting the challenge of added social responsibility, business is simultaneously struggling to combat some popular misconceptions.

One is that companies make a profit of 29 cents on each dollar of sales. The people who made up this survey figure also thought a profit of about half that -- 14-1/2 cents -- would be fair. How far they are from the truth. Manufacturers earned a profit of only 5.2 cents on each dollar of sales in 1966.

Other surveys have shown similar misunderstanding of the difference between profit and mark-up. We have a constant job of getting over to people that, <u>if</u> a profit is made, it is not because the mark-up was high enough to make it, but because it was low enough to give a selling price which attracted customers and because the cost of operation was kept to a minimum.

Another happy hunting ground for the critics of business is that manufacturers are among the rich of this country and inevitably the cry "Soak the rich!" follows. The theory is simple: If only the rich were soaked hard enough to carry their proper share of taxes, the rest of us would get a better break. Unfortunately, as the 1965 tax returns of the Department of National Revenue show, there just aren't enough rich.

According to the most recently available statistics, some fortunate Canadians have an annual income of $50,000 or more. There are fewer than

5,000 of them, equal to 0.1 per cent of all taxpayers, but they paid 5.3 per cent of all the income tax collected.

There are nearly five times as many in the $25,000 - $50,000 bracket -- less than 25,000 of them. They, as 0.5 per cent of the total, paid 7.8 per cent of the personal income tax collected.

At the next level, $15,000 to $25,000, there were 65,000 Canadians (1.3 per cent of the taxpayers) who paid 8.3 per cent of the tax total.

In these three categories we have two per cent of taxpayers -- about 100,000 of them out of nearly six million. They paid 22 per cent of all personal income taxes in 1965. I suggest they have already been well and truly soaked.

There you have two financial areas of misunderstanding.

To round out the picture of Canada's current economy, we are concerned with the problems of inducing more Canadians to buy Canadian-made goods; getting our export drive into high gear to meet the challenge of the Kennedy Round reorganization; meeting the conflicts of lower prices to meet world-wide competition and demands for ever-higher wages; expanding to provide more job opportunities for our growing population; some of which are further complicated by recent monetary devaluation and of course money cost and shortage.

Whatever the shortcomings of our business methods, no better way of developing our resources for the greatest good of the greatest number has yet been devised than our competitive enterprise system. It has provided a standard of life and a level of social security which are the envy of the world.

We must ensure its preservation by proving worthy of it. We must think in terms of an all-out effort to improve our total performance -- and this, Gentlemen, most certainly includes our ability to improve our air, water and soil quality control.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"SOIL POLLUTION CONTROL - - - AGRICULTURAL"

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There are two basic questions on this topic. Do we have soil pollution control programs in agriculture and if not, are we in a position to formulate effective control programs at the present time?

A soil pollutant has been defined as any substance which when added to the soil lowers the yield or quality of farm products, impairs the health of animals or humans, or which may contribute to subsequent air or water pollution. With regard to the human and animal health aspects, an important factor separating soil pollution from that of water and air is that both water and air are consumed directly by humans, soil is not. Thus any problems inherent in water and air pollution control are also present with the soil. In addition, we must know something about the transfer mechanisms whereby potential pollutants are transported from soil to a form in which it is contacted by humans or animals. The other important part of soil pollution is a more direct effect of soil pollutants on crop quantity or quality. We will discuss some of these aspects in more detail later but first let us return to the question of soil pollution control programs.

Do We Have Soil Pollution Control Programs in Agriculture?

Regarding the question "Do we have soil pollution control programs in agriculture?", the answer is both yes and no. No, we do not have direct legislation related to agriculture; however, the Ontario Water Resources Commission Act and the Air Pollution Control Act of 1967 are stated in general terms and are applicable when agricultural activities exceed the stated pollution limits. The Food and Drug Act of Canada ensures that food offered for sale shall not contain undesirable contamination of poisonous or hazardous substances. Also, the Public Health Amendment Act of 1967 now requires certification of waste disposal sites and has a provision for the Medical Officer of Health to order removal of waste on unapproved land and to order restoration of the site to a satisfactory condition. Some aspects of this Act could be of importance to the agricultural industry.

Indirectly, agriculture has soil pollution control programs built into the soil management recommendations. Fortunately, pollution control and efficient management go 'hand-in-hand'. Both fertilizers and pesticides cost farmers money and it is to their advantage to get the maximum benefit from a minimum application. Pollution problems can arise when the recommendations are not followed. For example, a farmer with a high-priced crop, is looking for a 100% weed or insect control program, and applies considerably more pesticide than recommended. The same situation can also arise with fertilizers. It is this excessive use that conceivably could require legislative control.

A strong argument can be offered for the disposal of municipal wastes on land. Nitrogen and phosphorus nutrients are difficult to remove in sewage treatment plants. As a consequence, the majority of the treatment plants in Ontario remove little of the added nitrogen and phosphorus compounds and simply discharge these nutrients as dissolved compounds in the effluent water. It is an established fact that these nutrients and the water can be of value to both crop production and groundwater recharge when applied to the land: when simply discharged into streams and lakes these nutrients promote algal growth and bring about accelerated eutrophication of the surface water supplies. The problem, of course, is one of precedent and economics. Standard methods are available for waste treatment -- why change? The recycling of plant nutrients from the land,

to food, to waste water, and back to both crop and forest land again makes good sense but would be uneconomical at this time for large cities such as Toronto. At present, Toronto's sewage sludge which has some nutrient and soil conditioning value was once offered for sale but now, because of insufficient demand, is dumped into landfills at the rate of about 180 tons per day.

Can We Formulate Effective Soil Pollution Control Programs in Agriculture?

Regarding the question "Are we in a position to formulate and enforce effective soil pollution control programs in agriculture?", a quick answer would probably have to be "not yet". Control programs certainly can be proposed at any time but whether they would be based on a good overall knowledge of the entire system is somewhat in doubt at present. The reason for this hesitance is that we really do not know enough about the behaviour of various potential pollutants in various types of soil and too little is known about the uptake and translocation of pollutants from the soil to plant tissue and the possible concentration in animal products when fed to farm livestock animals. In addition, the toxicology of chronic level feeding is not well established.

It seems appropriate at this time to review some of the important soil properties which influence the behaviour of potential soil pollutants.

The Soil

A soil contains solid, liquid and gaseous phases consisting of various organic and inorganic compounds plus microflora and microfauna. The structure and arrangement of the solid phase determine the form of the porous soil matrix. A reactive surface is usually exposed to this aqueous phase and at this surface various reactions (both chemical and biological) can take place between the soil solids and dissolved or suspended material. The gaseous phase is of importance with regard to the exchange of oxygen and carbon dioxide gases in particular with the soil surface. The biological component of the soil has 'to breathe' and the gaseous phase regulates this function.

It is the living component within the soil that is of the greatest importance as far as the breakdown or degradation of organic materials is concerned. Specific examples of organic materials are leaf litter, animal wastes and organochlorine insecticides. The size of the 'garbage can' depends on the biological activity within the soil.

A Potential Soil Pollutant

Let us explain what might happen by tracing the possible pathways that a pollutant might follow in the soil. A potential pollutant usually falls (or is deposited) on the soil surface or is mixed (or injected) in the upper layer of the soil. What happens from here depends on the chemical, physical and biological properties of the soil and the corresponding properties of the potential pollutant. Its solubility and volatility are extremely important. For example, a rather insoluble compound such as DDT would probably be present at concentrations in the parts per billion (ppb) range in the soil solution and even much lower concentrations (non-detectable) in the soil gaseous phase. A much higher concentration

of nitrate nitrogen (from both natural and artificial sources on fertilized land), probably in the parts per million range (ppm), would be present in the soil solution and there would be no detectable nitrate nitrogen present in the gas phase.

The potential pollutant can undergo various chemical and microbial reactions. Adsorption on soil solid surfaces, precipitation and transformation or degradation of the original substance are specific examples. Movement of potential pollutants in the soil can take place by diffusion (usually due to high concentrations near the soil surface) and by mass flow with the moving soil water or soil air. This movement can possibly be toward plant roots or be downward leaching to groundwater supplies. There could also be upward flow to the soil surface when evaporation is taking place.

Some potential pollutants can be absorbed by crops. Recent work by Harris and Sans[1] has shown that there is some absorption of organochlorine residues from soils by root crops but in no case did the residues exceed the tolerances established for human consumption. Difficulties can sometimes arise when feed-stuffs fed to cattle contain only trace amounts of pesticides. The pesticide can be concentrated in some animal products, such as milk, resulting in a preferential magnification of the pesticide concentration. Some herbicides are quite persistant and can lower the yield of a subsequent susceptible crop when present in the soil even in small amounts. This can happen when recommendations are not followed and is usually a result of misuse.

Subsequent water pollution can occur by leaching, by runoff, or by a combination of both. From a leaching standpoint, nitrate nitrogen and possibly some pesticides are the potential pollutants of most concern. From a runoff standpoint, the more insoluble compounds such as phosphates, the majority of the pesticides and animal wastes can be added. These problems will be discussed in detail in the following agricultural sessions of this conference.

Soil Variability

Soils generally vary from one location to another. Whether it be texture (percentage of sand, silt and clay), mineral composition, organic matter content, drainage or any other factor, the behaviour of the potential pollutant discussed in the previous section will probably vary with the different soil properties.

The soils in Ontario are quite variable. For example, travelling from Toronto north to Huntsville, one would pass through clay soils around Toronto, sandy soils around Lake Simcoe and very shallow and stony soils in the Muskoka region. Soil maps of Ontario point out the extreme variability that can occur even within the boundaries of a farm.

Conclusions

The problems of soil pollution are not as dramatic or as acute as with air or water pollution. To some extent this is because soil has a greater mass and

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[1] Harris, C.R. and W. W. Sans. 1967. Absorption of organochlorine insecticide residues from agricultural soils by root crops. J. Agr. Food Chem. 15: 861-863

and therefore is more difficult to pollute and also because soil is not consumed directly by humans as is the case with both water and air.

At present there are no pollution control programs in agriculture specifically designed for the soil. In some cases, we probably have enough information available to develop effective control programs. A specific example is the amount of animal manure that can be spread on the soil. An upper limit, based on the equivalent amount of manure containing 300 pounds of nitrogen per acre per year on corn or hay-pasture combinations can be recommended. The details behind this recommendation will be discussed later in the program by Professor T. H. Lane. In the majority of cases, however, a general knowledge exists on the behaviour of potential pollutants in soils, but we need more detailed information on the behaviour of specific pollutants in specific soils in order to formulate effective soil pollution control programs.

At the present time it is difficult to provide a strong argument showing the need for soil pollution control programs in agriculture. Soil pollution problems in agriculture are not critical at present and are not likely to be widespread in the near future. The present federal and provincial legislation provides adequate protection.

The engulfing of good agricultural land for suburban and industrial development perhaps should be briefly mentioned. At present, the economics justify this development, as is the case in the Niagara Peninsula; however, it is doubtful if this trend can continue forever. Land-use zoning programs which take into account the future needs of the province as a whole are badly needed.

The nitrogen and phosphorus case also deserves special mention. These compounds are plant nutrients when present in the soil; they are pollutants when present in water supplies. If at all possible, waste treatment processes should be developed which will return these nutrients to the land.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"WATER POLLUTION - - - AGRICULTURAL"

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In management of our agriculture industry, we can either accelerate deterioration of quality in our natural waters or direct efforts to retard, and hopefully bring pollution to a standstill. We have this choice today. Impairment of ground and surface waters caused by polluted soil, misuse of pesticides and fertilizers, and inadequate handling and disposal of animal wastes, has been demonstrated here in Ontario and elsewhere. Popular recognition of these aspects and their possible extent has only recently developed and is growing. We know clearly that environmental pollution is not confined to the city dweller or urban-oriented industry. Further, we understand that for water pollution to occur from agricultural practices, the prelude is often misuse of land and soil and other resources. In the next few moments, I propose to highlight the existing effort that is being made in Ontario to control the following potential pollutants:

1. sediment pollution caused by erosion;
2. pesticide pollution of water;
3. dissolved solids pollution of water resulting from crop irrigation and soil fertilization; and finally
4. bacterial pollution and deoxygenation of natural water by mishandling of animal wastes.

Policy for Water Use in Ontario

Recently, the Ontario Water Resources Commission revised its objectives policy for water quality in the province, recognizing that increasing competition for water requires a new approach to the control of quality in our lakes and rivers. Environmental pollution may affect our health, but it also has one other basic legacy -- it restricts or in some cases, makes impossible the use of water. One of the areas of water use that the OWRC recognizes as requiring protection from pollution is that of agricultural water use. Where water is used for farmstead water supplies, livestock and irrigation, whether from farm ponds, wells, or stream supplies, its quality must be protected for these possible uses. In this regard, the Commission's concern extends beyond the rural and agricultural community. We have responsibility for ensuring for those who wish to use water for any beneficial use, that the quality be compatible with other needs including public and industrial water supplies, recreation, fish, aquatic life and wildlife. To accomplish this, the agriculture and other industries must actively plan and carry out measures to control pollution. The Commission is not being unrealistic or excessive in these requirements -- rather it is asking people to be reasonable in their use of water allowing for its subsequent use by others. A more comprehensive review of this policy will be given by our General Manager in the program tomorrow.

In terms of pollution arising from erosion, pesticides, dissolved solids and animal wastes, this new policy means:

> That in the case of erosion, it is not reasonable, nor is it of benefit to downstream communities to have to maintain systems for clearing ponds, reservoirs and harbors of eroded silt. It is expensive -- we must eventually pay the price. We are told that the Mississippi River carries 0.5 billion tons of sediment every year, while in Toronto Harbour, the Harbour Commission is required to dredge over 1000 cyds (900 tons of silt and debris each day at the outlet of the Don River to maintain the shipping channel. This, by the way, cannot all be laid at the feet of agriculture, although much could be done by land managers to improve the situation.

In the use of pesticides, it is most unreasonable and potentially a hazard to health to use and apply pesticides in such a way as to contaminate soil and water. As our waterways are inevitably used for other subsequent beneficial uses, the quality requirements for these uses predicate very restrictive controls on the use of chemical pesticides to avoid the type of long-lived contamination often associated with their use.

While crop irrigation will always result in return flows higher in dissolved solids than the applied water, there is little that can be done by the individual irrigator to correct this change in the water quality. Although not considered to be a problem in Ontario today, changes in water quality resulting from irrigation are almost impossible to control.

In the case of plant nutrients -- nitrogen and phosphorus, that promote nuisance aquatic growths and contribute to other undesirable changes in surface waters, interference with several possible beneficial uses of water is now demanding that effective means be found to control the release of these materials to the environment. While there is reason to be mildly optimistic about chances for success in developing waste treatment systems that can remove nitrogen and particularly phosphorus from wastes, solution to the problems arising from agricultural land use will require a revolution in practice and technology.

Water pollution from animal wastes and feed lot run-off will receive special attention during the conference. Where the oxygen content of a receiving stream is depleted by drainage waters from livestock operations, possible interference with other beneficial uses of water can be prevented by the application of suitable waste handling and treatment technology. Adaptation of conventional biological waste treatment methods holds out promise for improved solutions to this difficult problem.

Ontario Program for Agricultural Pollution Control

1. Sediment Pollution by Erosion

In the soil conservation and land use program, Ontario's conservation authorities have worked with the Department of Agriculture in a number of projects. These have included: demonstrations of improved land management practices applied to gully control, farm pond construction, reforestation and pasture improvement, land judging competitions, assistance to landowners to build grass waterways and farm drainage systems, and projects to control stream bank erosion.

In a recent report the conservation authorities have drawn attention to the serious problems associated with stream bank erosion. Where at one time, farmers were able to keep up with breaks along river banks and clear away channel obstructions, it is now apparent that much good farmland is being lost with undermining of bridges, buildings, roads, etc. This is attributed to unwise farming practices and developments along rivers.

Much stream bank erosion results from livestock grazing the grass and growth along stream banks which often break down under trampling to expose materials. Land managers are encouraged to

consider fencing of stream banks with watering or cross-over places at points least subject to erosion. Plowing too close to a river bank will cause erosion, and buffer strips along the river banks should be maintained. In some cases stream bank stabilization and additional protection is required. Authority officials point out that regardless of the procedures used, erosion control measures are not permanent and must be maintained.

Other methods of soil management and stream discharge control include:

a. Modifying soil properties by adding soil amendments that cause the soil to be less subject to slacking, detachment, and transport;

b. Employing tillage, planting and cultivating techniques to trap and hold rainfall for infiltration into the soil to reduce the amount of soil erosion and carry over of potential pollutants into a stream;

c. Modifying of field slopes to intercept and impound runoff to allow for deposition of sediment which might be otherwise suspended and washed away; and

d. The discouraging of overgrazing of range lands.

2. <u>Pesticide Pollution</u>

It is known that agricultural and domestic use of pesticides can result in low level surface water impairment from runoff. Further we know that these low levels can be concentrated in the food chain of aquatic organisms.

The Ontario Herbicide Committee made up of representatives of the Departments of Agriculture, Health and the Ontario Water Resources Commission maintains a watch on the application in Ontario of all types of herbicides. The Committee gives attention to the use of chemicals as herbicides on crops and as controls for aquatic nuisance. The effectiveness and selectivity of marketed chemicals are appraised and each year the Committee reviews as required its annual publication "Guide to Chemical Weed Control". While the Federal Food and Drug Administration is concerned with residue levels in food and exposure to man, and the conditions under which products are marketed, the province through the Department of Health licenses commercial applicators and maintains a constant surveillance over the use of these chemicals. This work has taken a great stride forward with the opening early in 1967 of the Ontario Pesticide Laboratory at the University of Guelph, where it is possible to perform complete analysis on a wide range of pesticides.

Other laboratory facilities are provided by the Ontario Water Resources Commission.

The O.W.R.C. is particularly concerned where materials are added to water for the control of aquatic pests, and a rigorous control program has been carried on with the co-operation of Lands and Forests since 1962.

3. Dissolved Solids Pollution and Soil Fertilization

While research studies on nutrient removal by algae, aquatic weed control methods, and taste and odor problems related to algae have been carried out for some time by the O.W.R.C., the first concerted effort to examine the influence of land drainage on the waters of the Lower Great Lakes was commenced in 1964. Since that time the Commission has expanded this work and drainage basin studies have been carried on this past year to evaluate the influence of rural versus urban land drainage on the waters of the Great Lakes.

Whereas, the application of animal wastes as fertilizers presents a problem in managing the high nitrogen content of these wastes, chemical fertilizers provide man with another agricultural resource which, if well managed, can result in great benefit. If over-used these resources may lead to ground water and eventual surface water pollution.

Nitrogen applied to soil to minimize ground and surface water pollution, should be added in increments as needed rather than by applying a full season's requirement in one application. The application of the major nitrogen needs should be delayed until the crop is able to actively absorb the applied nitrogen. Many agriculturalists make use of the services of the University of Guelph in determining optimum rates of fertilizer application for particular soils. This practice should be encouraged.

4. Animal Wastes Management

When we learn that the farm animal population in Ontario produces an amount of waste equivalent to that from 45 million people, we realize the scale of the problem faced. An enterprise producing annually at a rate of 50,000 laying hens, or 5,000 market hogs, or 1,000 beef cattle, or 500 dairy cattle, generates a waste disposal problem comparable to a city of 10,000 persons.

Over the past year, the Commission has been represented on the Committee on Utilization of Animal Wastes organized by the University of Guelph in co-operation with the Department of Agriculture. Its concern has been the handling and utilization of animal wastes in crop production to recover beneficial nutrient elements necessary for other forms of life. Where production and utilization of animal wastes can be integrated with crop and livestock production, best use is made of this fertilizer resource in our expanding agricultural economy. The application, however, of either animal wastes or supplemental chemical nitrogen in excess of crop nutrient needs, is believed to increase the possibility of water pollution. Therefore, great care is required in the application of fertilizers. In some cases, where water-carried waste systems are used and sufficient land area is not available, waste treatment methods are required before application to the land to avoid over-fertilization and subsequent water pollution. In still other cases where it may be necessary to introduce the waste following treatment into a receiving water, special care must be taken to avoid interference with other possible water uses. While much of the O.W.R.C. research program in waste treatment has been oriented to municipal problems, this has been re-directed of late to answer many questions on the treatment of animal wastes before application to either soil or water. These are pressing problems for those operations where land is restricted in area and a high degree of waste treatment is required. In recent months the Department of Health has become active in

the difficult problem of inadequate solid wastes management which has a large bearing on the soil and water pollution problems.

Practical Guidelines for Avoiding Water Pollution from Application of Pesticides and Use of Animal Wastes

In this section, attention will be drawn to those known practical measures that farmers may use today to control pesticides and animal wastes. Certainly there are many areas of needed research; however, we cannot wait for the answers to all questions before applying ordinary common sense in correcting many obvious problems.

Pesticides

1. Select a pesticide that will not only destroy the target pest, but also be the least damaging to beneficial plants and animals, and be attenuated or degraded in a reasonably short time following destruction of the pest.

2. Apply the selected pesticide in the right place, at the right time, in the correct amount, and properly distributed to obtain the most effective results with the least hazard to beneficial life.

   Proper procedures include: using machines and techniques that most accurately direct and apply the pesticide; use of adhesives for maximum pesticide retention on the target area; application of minimum amounts at the right time for best control; use of spot applications in preference to broadcasting wherever practical; and use of weather forecasts to avoid rain removing foliar-applied pesticides and drift over water from strong winds. Ground applications should be used whenever practical to reduce the hazard to surface water pollution from aerial sprays.

3. Reduce drift from ground-driven applicators by using low spraying pressure and large droplet size, or by substituting granules for dust or sprays.

4. Use granular materials in preference to sprays whenever feasible. This avoids: probability of accidental back siphonage and spillage (of the pesticides or sprayer cleaning water) near a well or stream; fiber and plastic containers for granules and dusts do not present storage problems with corrosive liquids and are more easily destroyed than metal or glass containers.

5. Prevent back siphonage into a well or stream by supporting water hose or pipe above the maximum liquid surface in the sprayer tank to provide an air gap. Sprayer cleaning water should never be dumped near (several hundred feet) a well or stream.

6. Store pesticides in a building with an impervious floor and lower wall and control the access to it.

7. Read before using. An important factor in the safe use of pesticides is to follow labelled instructions.

8. Substitute biological control of pests for chemical control whenever possible.

Recommendations for Management of Animal Wastes to Avoid Water Pollution

1. In the Field

   a. Field-spread wastes thinly so as not to exceed the rates for optimum nitrogen use.

   b. Balance waste-borne plant nutrients with chemical fertilizers for optimum plant growth.

   c. Incorporate solid wastes with the soil during or soon after spreading, taking account of the best time for fertilization in crop production.

   d. Do not spread wastes on frozen or water saturated soils in areas where surface runoff will transport wastes into surface water.

2. In the Feed Lot

   a. Locate feed lots where runoff into streams and soil infiltrate-borne nitrogen will have little effect on the future use of ground and surface waters.

   b. Separate or divert runoff from areas of higher elevation, including roofs of buildings, from precipitation falling directly into the lot.

   c. Construct solid waste storage areas within or adjacent to feed lots to control leaching of stored wastes by precipitation and run-off.

   d. Construct necessary settling basins to intercept all feed lot run-off and retain all settleable solids. Field spread retained solids and supernatant seasonally.

3. In the Roofed Livestock Production Unit

   Install proper waste handling system, taking into account the location of the unit and facilities for crop utilization or waste disposal, to avoid pollution of ground and surface waters.

The Future

There are two considerations respecting the future control of water pollution from agriculture: firstly, the state of our knowledge and the areas where further information is required; and secondly, the improvement of pollution control management programs. Included in the second part is the pursuit of needed knowledge and development of rational planning policies and programs to make the best use of the knowledge gained. In concluding this paper, I wish to draw attention to several areas of information requiring attention:

1. Improved understanding of the eutrophication or aging process in our lakes -- world-wide attention is being devoted to this problem. In Canada, the Fisheries Research Board has launched a long-term study of this problem in the Great Lakes, while in Ontario, the O.W.R.C. has numerous inventory programs, surveys, and research projects in progress.

2. Increasingly better measures of the magnitude and effects of land erosion on our drainage basins is required -- extension of the federal program for gauging sedimentation and erosion is desirable. The O.W.R.C. maintains a water quality monitoring program which provides an understanding of the suspended materials' loads our streams carry.

3. More information is required on the fate of pesticides in irrigation water and the pollution potential of drainage waters contaminated by pesticides.

4. With increased research on the use of biological pest control methods, balanced use with improved chemical control methods should be encouraged.

5. Better information is required concerning:

   a. The quantities of water used in feet lot operations;

   b. The range of nutrient (nitrogen and phosphorus) concentrations and other characteristics of manures produced under specified conditions.

6. Development of waste treatment processes that would permit biological or other stabilization of animal wastes for crop utilization or disposal into receiving waters.

7. Determination of the loss of nutrient elements by soil erosion and the quantities and types of fertilizing materials that enter ground water with descending soil moisture.

8. The times and rates of maximum application of fertilizer that will not contaminate ground water.

9. Information is required to evaluate effects of varying quality water on soil in relation to the effects on water movement and plant growth.

10. There is need to:

    a. Delineate localized areas of polluted ground water;

    b. Properly close abandoned wells, improperly located and constructed wells and other openings into the ground water supply.

    c. Locate new wells such that zones of influence do not overlap known or suspected areas of polluted ground water.

11. Develop meaningful plans for water use encompassing needs for agriculture, fish, aquatic and wildlife, industrial and public water supplies and recreation that will integrate the efforts of existing programs organized to control environmental pollution.

12. Develop awareness in the individual land manager of the readily applicable measures he may use today to control soil and water pollution.

It is evident when dealing with large drainage systems that include the Great Lakes, piece-meal short term planning cannot ensure continuous availability of water with a high quality. The commonly accepted notion, that each of the Great Lakes is of such size and unlimited capacity for dilution of all sorts of

drainage waters, has been proven wrong and must be rejected. Rather, the planning effort in relation to persistent slow decaying pollutants must become preventive-oriented as large scale problems, once permitted to develop, become almost impractical to correct.

In the Commission's water quality management program, drainage basin planning studies are underway to determine the magnitude of water quality change occurring in relation to water uses and needs. These include agriculture, land use, and other water uses. By utilizing the resources of modern computation methods in analysis of the complex system problems involved in water use, the Commission expects to define the limitations to be placed on each waste source introduced to the environment.

In rural areas where organized drainage and waste treatment systems are in use, this approach will also apply. While research is needed in many areas, we must depend upon the ordinary common sense of each farmer to take those steps possible today to keep the problems of water pollution within manageable limits.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"THE AIR POLLUTION CONTROL ACT AND AGRICULTURE"

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The purpose of this paper is to provide information on how the Ontario air pollution control program, under the Air Pollution Control Act 1967, will affect agricultural operations. In order to do this it is necessary to briefly review the Act and provide an insight into the operations of the Air Pollution Control Service.

Air pollution legislation was originally found in The Municipal Act, but was limited in scope to smoke control. A Select Committee was established to study this problem and as a result of their 1957 report, the Air Pollution Control Act 1958 was passed. This Act delegated total control to the municipalities with the Province in an advisory role. In 1963, the Act was amended to provide for control of new industrial sources by the Province, smoke control remaining with the municipalities.

Financial assistance and training of inspectors at no cost to the municipality were offered as inducements to stimulate activity at the municipal level. The results were to put it quite bluntly disappointing. Some 26 municipalities passed by-laws under the Act, while two continued to operate under the provisions of The Municipal Act. Only four municipalities had a full-time staff working on air pollution, the remainder operated on a part-time basis, combining it with other functions. Some municipalities passed the by-law and forgot about it.

With this history it became apparent that if any progress were to be made in Ontario, the control of air pollution must be vested in one central agency. As a consequence, the Air Pollution Control Act 1967 was passed whereby the Province assumed the total control function. This Act was passed in June and was proclaimed October 26th. There is no provision in the Act for delegation of authority to the municipalities.

The salient features of the Act are as follows:

1. Authority to control new stationary sources of air pollution by requiring a certificate of approval before such new sources may be created. Also covered in this provision is the requirement for existing sources which expand, alter or modify to obtain a certificate of approval prior to undertaking such work.

2. Authority to control and regulate all sources of air pollution through investigations by provincial officers and orders of the Minister of Health.

3. Establishment of an Air Pollution Control Advisory Board to review recommendations of a provincial officer and, after a hearing, to report with its recommendations to the Minister.

4. Authority in the Minister, after investigation, to order the discontinuance of the discharge of any air contaminant in unusual cases where such discharge creates an immediate and serious danger to the health of the public, and where a delay in following the usual procedures under the Act would prejudicially affect the public.

5. Provision for a Board of Negotiation to negotiate the settlement of claims of persons whose crops, or livestock are damaged by air pollution resulting in economic loss.

6. Authority to control and regulate the discharge of air contaminants from motor vehicles by setting standards of emission and requiring motor vehicles to be equipped with systems or devices to prevent or lessen the emissions of air contaminants.

7. Provision for investigation of air pollution problems and for research and educational programs in the field of air pollution.

In order to provide for an orderly transition period from municipal to provincial control, existing municipal by-laws will remain in effect until such time as the provincial regulation is made effective in any area. To accomplish this regulations may be general or particular in application and may be limited as to time or place or both.

It should be noted here that this phasing applies primarily to the control of combustion sources since the enforcement of such regulations requires personnel located in the area concerned with daily observations being made. The control of industrial sources of air pollution will proceed simultaneously since it will not be limited to specific areas, rather it will be applied on a province-wide basis.

Industry control will be on the basis of the type of industry. Operations of the same type will be simultaneously subject to control regardless of location.

For purposes of administration, the Province will be divided initially into seven regions. These regions are such as to take into account the economic factors, population densities and health regions. With a few minor exceptions the air pollution regions will conform with those used by other provincial departments. Depending upon the size of the region and economic activity, each region will be divided into two or more districts. Each region will be headed up by an engineer, as will each district. Inspectors will be located throughout the districts and their primary purpose will be to enforce the regulations concerning combustion sources, and to assist the engineers by making observations and investigating complaints.

It is planned during the fiscal year 1968-69 to establish offices at Sarnia, Windsor, London, Welland, Hamilton, Kitchener, Oakville, Brampton, Sudbury and the Lakehead.

So far I have dealt primarily with the legislation and administrative aspects of the provincial air pollution control program. I would now like to deal with the control aspects. It is our opinion that control parameters should be based primarily upon the effects of pollutants on human health and well-being, vegetation, livestock, economic loss, nuisance, discomfort and aesthetic values. In order to do this, it is necessary to control the quality of the ambient air in the context of its usage. This may be done by using ambient air quality criteria and taking into account the local meteorology, topography, and land usage to arrive at allowable emission rates. In actuality this means that similar operations may be permitted to emit different amounts of pollutants dependent upon location.

Meteorology also plays a very important role in the permissible emission rates, since meteorology controls the quality of our ambient air. Under normal atmospheric conditions pollutants emitted to the atmosphere will disperse quite rapidly. However, when temperature inversions are experienced the concentration of pollutants builds up. The frequency and duration of inversions therefore

determines what the atmosphere can safely absorb. In Ontario we are blessed by having the Great Lakes provide us with fresh water supplies, cheap transportation and so on. However, they do create adverse meteorological problems in specific areas of the Province.

There are certain instances where emission standards are both logical and desirable because of technology and multitude of sources. I refer now to the use of the Smoke Density Chart for combustion sources and standards for automobile emissions.

To undertake a control program based on the concepts mentioned, it is, of course, necessary to provide supporting services. The Air Pollution Control Service is composed of the following sections: Approvals, Abatement, Meteorology and Air Quality, Phytotoxicology, Vehicular Emissions, Laboratory and Administration. I should point out here that the information function will be handled by the Department's reorganized Information Branch. Such an information program is currently being planned and results should be forthcoming shortly.

One of the most important aspects of any government program is interdepartmental liaison. You may recall that last year the Honourable John Robarts set up an Advisory Committee on Pollution Control. This Committee is composed of the Deputy Ministers of those departments dealing with resources and pollution. In addition, a special sub-committee on air pollution has also been appointed. The sub-committee is made up of senior staff members from the departments of Agriculture and Food, Transport, Economics and Development, Energy and Resources Management, Lands and Forests, Mines, and Municipal Affairs under the chairmanship of the Department of Health. Since air pollution affects all aspects of our way of life, one of the major jobs of this sub-committee is to ensure that in the resolution of air pollution problems all aspects are considered and that actions of the individual departments do not detract from the provincial air pollution control program.

Gaseous sampling on a continuous basis is both costly and time-consuming, consequently progress will be slow. When one takes an analytical chemical method and automates it, the skilled manpower requirements in order to obtain meaningful results are very high. In addition, the delivery of this specialized equipment is very slow since it is not mass-produced and there are many technical difficulties.

Because of the mass of data which becomes available from automated sampling procedures, it is necessary to rely on the latest data handling techniques and computers in order to analyse the information. Such a program is already underway within the department.

Many of you may not be aware that the Province supports research in the air pollution control field. At the post graduate level grants are given to Ontario universities for research projects, dealing with the fundamentals of control. Such grants provide two benefits: firstly they broaden our knowledge since the results are available to all and, secondly, they provide for training of people entering the field.

It is our feeling that we have set up an air pollution control program, broad in concept, realistic in approach and flexible in its application. We know

that we will have to make some changes as we progress since no plan is perfect. We are realists enough to also know that in order to control air poll tion, we are faced with a long-term concentrated effort requiring co-operation from all.

We have been realistic in our approach. Those who are polluters must also be realistic in facing up to their responsibilities to provide cleaner air for the people of Ontario.

In applying the provisions of the Act to agricultural operations there are two basic divisions, namely those who are affected by air pollution and those who create air pollution.

Let us deal first with those who are affected. In this instance Section 11 of the Act is applicable. This Section states that when a person complains that air pollution is causing or has caused injury or damage to livestock or to crops, trees or other vegetation which may result in economic loss, he may within 14 days after the injury or damage becomes apparent request the Minister to conduct an investigation.

After conducting the investigation, a copy of the report of the findings shall be given to the claimant and to the owner or operator of the source of air pollution alleged to be the cause of the injury or damage.

Provincial personnel will conduct the investigation and in order to do this a phytotoxicology section has been established within the Air Pollution Control Service, to study the effects of air pollution on vegetation. The appointment of the head of this section is expected to be made within the next two months. Other appointments will follow shortly after.

In conducting the investigation, visual inspections will be made since injury by air pollution frequently manifests itself in the form of characteristic visual patterns. However, other causes of injury will frequently cause similar visual patterns so that it will be necessary to obtain vegetation and soil samples to determine if the cause is other than air pollution. It may also be necessary to carry out air sampling and analysis.

Farm management practices will also have to be taken into account since mismanagement can cause reduction in yields which could be attributed to air pollution.

It is apparent that in determining the cause of such injury, many people will be involved, all specialists in their own disciplines. The Air Pollution Control Service will not have all these people on staff, rather it will have several specialists who will co-ordinate the investigation and utilize the personnel of the Department of Agriculture and Food and of the University of Guelph.

After the initial phase of the investigation has been completed, the owner of the source of air pollution allegedly causing the injury or damage will be notified in order that he may inspect the injury or damage, take samples and conduct tests and examinations for his own information and protection.

Assuming that the investigation defines the cause of the injury or damage and the source, the two parties concerned are free to reach a settlement. The complainant has the option of notifying the Minister and the owner that he wishes

to have his claim for injury or damage negotiated by the Board of Negotiation, and he shall state the amount of his claim within a reasonable time after it can be determined.

Should the two parties not be able to reach a settlement within 30 days after notice of the claim has been given, either party may request the Board to act. The Board will then assess the injury or damage in respect to which the claim was made and will meet with both parties to arrive at a settlement.

This procedure shall be without prejudice to any subsequent proceedings should settlement not be reached.

The Board of Negotiation will be composed of two or more members and may sit anywhere in Ontario.

Proceedings under this section of the Act do not apply to injury or damage caused by sulphur fumes arising from operations designated in The Damage By Fumes Arbitration Act. Such operations are defined as "the smelting or roasting of nickel-copper ore or iron ore or from the treatment of sulphides for the production of sulphur or sulphuric acid for commercial purposes ..."

In such cases the Sulphur Fumes Arbitrator of the Department of Mines should be notified at either the Parliament Buildings or at his office in Sudbury.

Since all new sources of air pollution must now obtain approval prior to construction, and all existing sources will be subject to control, the incidents of agriculture injury and damage will diminish and the number of cases referred to the Board of Negotiation will be minimal.

Traditionally the farmer has not been considered as operating an industrial operation and until recently this has been true. However with the advent of mass production of eggs, poultry, and feed lots for cattle and hogs this situation no longer exists. Consequently, operations such as those mentioned are, in our opinion, classified as industrial operations and subject to the same provisions of the Air Pollution Control Act as other sources closely allied to agriculture, such as, rendering and meat packing.

All of these operations have inherent odor problems and all can be controlled so as to keep the odor below the nuisance level.

The Air Pollution Control Service is working closely with the Department of Agriculture and Food and will shortly have an information booklet available covering the air pollution measures which are necessary for egg, poultry and feed lot operations. Meat packing and rendering operations will also shortly be advised as to the requirements necessary to control their odor problems.

When one investigates odor complaints from egg, poultry and feed lot operations, two or three causes are readily apparent. Usually the disposal of dead poultry is completely inadequate, the disposal of wastes leaves a lot to be desired, frequently due to poor operating practices and the operation being located in close proximity to residences. We have seen poultry houses within 200 feet of residences and the ventilation fans blowing directly toward the residences. In these circumstances it is readily apparent that the agricultural operation is not taking the required interest in the locating of such operations within its boundaries.

We feel that the legislation, and the program of Air Pollution Control Service is realistic and practical. It does require the co-operation of all facets of our society. If this co-operation is not forthcoming, then the punitive sections of the Act will be enforced and they are substantial.

While the Air Pollution Control Act does not deal specifically with it, it is readily apparent to those working in the air pollution field that we must arrive at a better method of land usage. The Province needs industrial growth to maintain its economy, it also needs more productive agricultural operations to supply the needs of a growing population, one that will continue to grow with an expanding economy. These three -- industry, agriculture and municipal development must work together.

It is a well-known fact that we have farming operations which are uneconomic due to poor management or because they are located on marginal farm lands. We also have industry located on, or adjacent to, prime farm land and our municipal expansion is also taking prime land out of production.

Air pollution from industrial, municipal and agricultural sources can be minimized and all three types of operations can be compatible if the proper planning is used.

The agricultural community is faced with a challenge, it must make decisions and work with the other facets of our economy. The Air Pollution Control Service can provide a limited protection but it cannot protect the agricultural industry from itself.

ONTARIO POLLUTION CONTROL CONFERENCE

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"INDUSTRIAL WASTE CONTROL PROGRAMME IN ONTARIO"

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Introduction

The pollution of our air, water and soil resources by the wastes generated by man in this complex industrial-urban society has aroused much public interest and concern. Industrial wastewaters are only one cause of water pollution, but because of the volume of water used in industrial processing, and in some cases, the visible effects of industrial discharges on receiving streams, much public attention has, and continues to be, focused on industry. The need for prompt and vigorous action to ensure that available water resources will continue to serve the ever-expanding demand on a perpetual basis is evident.

With industry, the word "use" can mean intake, consumption, recirculation or any other function of water you choose it to mean. "Intake", sometimes called "withdrawal", is the water taken from a source. Consumptive use refers to the disposition of water in such a manner that it is no longer conveniently available to others in the immediate vicinity. In industry, water is consumed when added to beer, soda, or lesser-known products, or when it becomes vaporized in cooling towers. Non-consumptive use is the difference between water intake and consumptive use. Cooling water and process water in industry are for the most part non-consumptive uses, and it is the former which gives rise to the large volumes associated with the majority of the manufacturing operations.

In some quarters, the adequacy of the regulatory programs and the technology available to correct the pollution problems at existing plants and to keep pace with those created by new industrial growth is being questioned. The frequent industrial attitude of keeping both progress and problems relating to pollution control under their hats has not helped this situation, and to some extent, may have even permitted the public to become confused as to the nature of the controls which have been instituted in recent years. The objective of this talk, therefore, will be to define the nature and effectiveness of the industrial pollution control programs being carried out under the provisions set out in The Ontario Water Resources Commission Act.

Nature of the Control Program

The O.W.R.C.'s Division of Industrial Wastes has been assigned three prime responsibilities in industrial pollution control:

1. The routine surveillance of all industries to ensure that measures are being taken towards the control and/or abatement of industrial pollution.

2. The review of all waste treatment proposals for new or expanding industries.

3. The provision of a degree of technical assistance to industries and municipalities in developing solutions for new and/or persistent waste treatment and disposal problems.

Staff of the Division are also involved to a degree in the regulation of industrial discharges to municipal sewers, particularly in the development stages of municipal sewage treatment projects and in dealing with problems associated with the presence of industrial wastes in existing municipal sewerage systems.

The Division has a technical staff of 31, embracing a number of disciplines including chemists, chemical engineers, civil engineers, and engineering technologists. Two-thirds of the staff are employed in the surveillance program of the Field Services Branch while the remainder comprise the Design Approvals and Special Projects Branch. To a large extent, the program is based on the premise that limited technical advice and counsel can be a powerful spur in pollution control.

Emphasis in the industrial surveillance work of the Field Services group is placed on process studies and in-plant control of wastes leading to the preparation of reports which often indicate areas where the waste load can be reduced, or provide guidelines for the design of new or improved waste treatment facilities. With the above information available as background, follow-up meetings are held with management and technical personnel of problem industries to establish time schedules for the planning, engineering and construction of treatment works.

The suitability of waste treatment or control is determined by comparing effluent analyses with the following:

1. The Commission's "Objectives for Industrial Wastes Control in Ontario".

2. The Commission's "Objectives for Water Quality Control in the Province of Ontario".

3. Schedules of mandatory sewer-use controls adopted by municipalities for the discharge of wastes to municipal sewerage systems.

The interpretation is based upon field data acquired in each case involving chemical, physical, biological or bacteriological analysis of waste samples, and attempts will be made in the future to accurately relate this data to the assimilative or dilution capacity of the receiving watercourse.

During 1966, a total of 1,516 field visits were carried out as part of the routine surveillance of the 1,800 industries under the active consideration of the Division. More than 360 formal industrial survey reports were issued to industries in the Province, and Division staff participated in over 200 meetings and consultations with industrial and/or municipal representatives during the same period.

The Design Approvals and Special Projects staff, in addition to the review of engineering plans for the collection, treatment, transmission and disposal of wastes from new or expanding industrial operations and the preparation of certificates of approval as required by Section 31 of the Act, provide specialized technical appraisal of difficult waste treatment problems, and carry out detailed industrial studies leading to the preparation of reports for certain types of industry on a province-wide or area basis.

Since July, 1965, when the Design Approvals and Special Projects Branch was established, the Commission has issued over 120 certificates of approval for industrial waste treatment works involving an estimated capital expenditure of over $24,000,000.

This capital outlay does not provide a true indication of funds expended on industrial waste control in the Province during this time period. Such items as in-plant modifications to permit re-use of water or recovery of by-products, the installation of pretreatment works at industries already on municipal sewers, or the re-direction of waste flows to municipal sewers do not qualify for formal approval under the provision set out in the Act. Furthermore, in view of the fact that a large number of industries can discharge their wastes to municipal sanitary sewers when a new or expanded sewage plant is built in a municipality, a substantial expenditure on the part of municipalities in industrial pollution control comes about indirectly. Part, or all, of this capital is recovered from industry via normal municipal taxes or special surcharges.

Legislation Relating to Industrial Pollution Control

The O.W.R.C. Act contains wide authority in the field of water supply and pollution control and a brief review of the legislation as it pertains to the industrial waste control program is in order. In the Act, a broad definition is given for sewage which encompasses surface drainage, domestic wastes, commercial and industrial wastes.

Under Section 26, the Commission has the right to apply to the courts for an injunction and this power is really the "ultimate weapon" of public authority to control pollution of waters in Ontario. This section also makes provision for the Commission to apply for what is called an "ex parte" injunction in emergency situations where public health or recreational implications are such that a speedy remedy to eliminate a pollution source is required.

It is the view of our Legal Branch that permanent injunctions should only be sought where companies have been under investigation for years, have been the subject of inspections, reports and recommendations, and where the Commission will already have exercised a number of its other powers under the Act without having been able to eliminate the pollution. Such cases are not emergency cases, but are hard cases and frequently long standing. Fortunately, we do not have any industries that fall into this category yet. In the past, the Legislature has been reluctant to accept injunctions granted by the courts where economic and social factors were opposed to a plant being closed down and where the installation of treatment works was not possible before the effective date of the injunction.

Section 27 is the essential punitive element in the Act and provides for the prosecution of municipalities, industries or persons who discharge polluting materials to receiving waters in the Province that may impair the quality of the water. The maximum penalties under this section are a $1,000 fine and/or a year's imprisonment.

It should be emphasized that the question of whether the discharge of some material does, or does not, have the potentiality to impair is itself a question of fact to be determined by a magistrate, and the opinion of the Commission is not relevant. The court must act upon the basis of evidence and this evidence normally includes the testimony of expert witnesses. Under the law of Ontario, the opinion of an expert, once his qualifications have been established, may be received to establish the effect of an effluent upon receiving water. The accused

may call his own experts and the experts may disagree. The court in deciding: "Does this material that was discharged have the potentiality to impair the quality of the water of this watercourse?" -- is at liberty to believe one, and reject the views of another, as in the case of any witness.

Section 31 empowers the Commission to require individuals, industries or municipalities to submit plans for the establishment, extension or modification of waste treatment works where the effluent from such works is to be discharged to a natural watercourse or storm sewer. This section is related to the previously mentioned system whereby certificates of approval are issued for the construction and/or modification of industrial waste treatment facilities. It is to be noted that the Act also contains a section (32) which permits a public hearing to be held prior to a certificate being issued.

Section 47 empowers the Commission, subject to the approval of the Lieutenant-Governor in Council, to make regulations in two areas. Subsection (f) regulates and controls the content of sewage entering sewage works. Subsection (g) prescribes standards of quality for potable or other water supplies, sewage and industrial waste effluents, receiving streams and watercourses. Thus the Commission can, if necessary, regulate and control the character of industrial effluents being discharged to municipal sewers or watercourses.

To date, the Commission has not chosen to make regulations under either of these subsections although, with the recently announced Policy Guidelines relating to Water Quality Objectives for the Province, some form of permit authorizing effluent concentrations for specific industries in certain drainage basins may be required in the future. More will be said later concerning Commission policy relating to subsection (f) when the responsibilities of municipalities in pollution control are reviewed.

Section 50 empowers the Commission, with the approval of the Minister, to require that investigations, reports and even the construction of treatment works be undertaken where waste disposal is deemed to be unsatisfactory. Failure to comply with a "Requirement and Direction" issued by the Commission under Section 50 could lead to the use of Section 53 which permits investigations, reports or construction to be undertaken by the Commission at the expense of the individual, industry or municipality involved.

Last year (1966), there was added to the O.W.R.C. Act a provision (Section 50a) by which, if the Commission was of the opinion that the discharge of sewage into a sewage works was interfering with the operation of the works, it could require any municipality or person by notice to stop or regulate such discharge or deposit or take such measures in relation thereto in such manner and within such time as the notice may require. The penalty for contravention is up to $200 per day.

This section applies to industry, and any industry that discharges toxic substances; for example, that may kill the bacteria in a treatment plant may be liable to prosecution under this section regardless of whether the plant is operated by the Commission or by the municipality, and regardless of whether the municipality has, or has not, adopted a pollution control by-law.

The answer to the pollution caused by many industrial concerns whose effluent is now being discharged to a natural watercourse is often to get the

industry and the municipality together to negotiate an agreement by which the municipality will take the wastes in return for special payment by the industry, and where appropriate, the provision by the industry of some form of pretreatment.

The Commission has been given special powers to enable it to put pressure both on an industry and on a municipality to see that this is done. It can issue "Requirements and Directions" to an industry under Section 50 with a penalty for up to $200 per day for failure to carry them out. It can also report to the clerk of a municipality in writing under Section 38 .. "that it is of the opinion that it is necessary in the public interest that water works or sewage works .. be established, maintained, operated, improved, extended, enlarged, altered, repaired or replaced ..". The municipality is then required by the section to "forthwith do every act and thing in its power to implement the report of the Commission". The penalty for non-compliance is up to $500 per day.

By the time the Commission arrives at the point where it is prepared to issue "Requirements and Directions" to an industry, and simultaneously, to report to a municipality, it is extremely probable that both the industry and the municipality will be fully aware of the technical problems and costs of treatment in the sewage treatment plant, or of pretreatment on the property of the industry.

In the early years of the Commission, emphasis in the program of industrial pollution control was placed on education, persuasion and pressure before prosecution. However, in the past two years alone, as part of an intensified program of industrial waste control, 15 charges under Section 27 of the Act have been laid and all except one, which is now being appealed, have resulted in convictions or guilty pleas by the industries concerned.

In the same time period, "Requirements and Directions" Under Section 50(1), subsection (a), of the Act have been served on six industries requiring them to submit to the Commission plans for treatment of their wastes. One injunction under Section 26 (1) was obtained and was subsequently withdrawn when the firm concerned agreed to institute immediate corrective measures to overcome the pollution problem.

It should perhaps be pointed out at this stage that while the sanctions of the law have and will continue to assist in eliminating pollution, I do not agree with the concept that progress in pollution control can be measured by the number of successful prosecutions carried out each year. I believe, from experience, that some of the most effective water pollution control systems in Ontario have resulted from measures voluntarily undertaken by industry in collaboration with the Commission.

This short summary should help in dispelling the often-heard criticism that the legislation is inadequate to control industrial pollution and what exists is never used.

Responsibilities of Municipalities in Pollution Control

Of some 1,800 wet process industries under active consideration by the Commission's Division of Industrial Wastes, a high proportion of these (>50 per cent) discharge to municipal sewerage systems in the Province. The final disposal of wastes from the metal finishing industries is often carried out in this

manner. This method of disposal, with adequate pretreatment regulated by local by-laws, is generally the most satisfactory and economic for industry of all types.

Although the Commission does not exercise direct control of industrial wastes that are discharged to municipal sewers, surveys are nevertheless carried out to evaluate industrial loadings and to assist municipalities in effecting controls to protect sewerage systems and to control sewage treatment plant loadings. Most of the municipalities in Ontario in which industrial waste loadings are significant or in which sewer-use problems have arisen have been surveyed and detailed reports made available for municipal use.

It is the Commission's view that municipalities should assume a large measure of responsibility for the control of industrial wastes being discharged to sewer systems. In this connection, the Commission encourages municipalities to:

1. Be aware of all industries on their sanitary sewer systems and to have current data on waste flows and characteristics available. The location of connections to the sanitary and storm systems, and manholes should also be noted on a municipal plan; and

2. Enact and enforce suitable by-laws to regulate and control the discharge of industrial wastes to the sanitary sewer system. Provisions should be included in such by-laws for entering into special agreements with industries not able to meet the by-law limitations and that have wastes amenable to treatment.

Such agreements should specify the nature and degree of pretreatment required at the industry before discharge of wastes to the sewer system is permitted. A Commission publication dealing with the many aspects of control of industrial wastes discharged to municipal sewerage systems will be available in the near future.

Status of Industrial Pollution Control in Ontario

There are approximately 9,000 manufacturing and commercial enterprises in the Province, and of this total about one-quarter are manufacturing plants utilizing wet processing operations and hence, are sources of liquid industrial wastes. Many of these plants are located in the larger urban centres and as such, they are dealt with by the municipal pollution control authorities through the use of sewer-use by-laws. The Division of Industrial Wastes is at present concerned with the liquid waste disposal practices of about 1,800 wet processing industries, about one-half being located in municipalities in which the O.W.R.C. operates sewage disposal plants.

A recently completed review of sources of industrial pollution in the Province showed that the major pollution problems, in terms of the number of plants without acceptable control facilities, are associated with the pulp and paper, mining, steel, and food processing industries, and to a lesser extent, with the oil and chemical, plating and metal finishing, tanning and rendering, textiles and service industries, such as railways, power utilities and trucking.

The major waste problems associated with the effluents from these industrial classifications include:

1. Pulp and Paper

a. The reduction of suspended solids to the lowest practicable levels;

b. The removal of toxic and taste and odor producing substances;

c. The reduction of biochemical oxygen demand (BOD) to acceptable levels by some form of "secondary" treatment.

2. Mining, Milling and Smelting

a. The control of waste rock or "tailings";

b. Correction of low pH in mine waters and the treatment of other waste streams to remove heavy metals, radio-activity and turbidity.

3. Primary Iron and Steel

a. The control of oil;

b. The treatment or elimination of spent pickle liquor, phenol, ammonia and cyanides.

4. Food Processing

a. The reduction of suspended solids, grease and BOD carried in the wastewaters, and in some cases, the correction of pH.

5. Oil and Chemical Processing

a. The control of wastes containing phenols, oils and other dissolved organic compounds as well as nutrients.

6. Plating and Metal Finishing

a. The elimination of oils, suspended solids, toxic substances and metals, and the control of pH.

7. Tanning and Rendering

a. The reduction of BOD and suspended solids to acceptable levels;

b. The control of toxic heavy metals, pH and odors.

8. Textiles

a. The control of fibre and pH levels and the reduction of BOD by biological treatment.

9. Service Industries (Railways, Power Plants and Trucking Firms)

a. The control of oil and suspended solid losses;

b. The elimination of problems associated with thermal pollution.

Table I gives the number of industries in the industrial classifications described previously that are under active surveillance by O.W.R.C. staff and

provides an indication of the money spent in each classification between the years 1957 and 1967 to overcome some of the problems mentioned. A miscellaneous classification of "Manufacturing and Metal Working" has been included to cover a group of industries engaged in machining, painting, pickling, etc., operations prior to assembly of manufactured products.

Industrial Classification	Total No. of Plants	Estimated Capital Cost of Treatment Works - (1957-67)
Pulp & Paper	42	$ 35,000,000
Mining, Milling & Smelting	107	25,000,000
Primary Iron & Steel	7	15,000,000
Food Processing	891	1,538,000
Oil & Chemical Processing	172	30,700,000
Plating & Metal Finishing	160	5,300,000
Tanning & Rendering	28	600,000
Textiles	64	52,000
Service	36	200,000
Manufacturing & Metal Working	310	3,700,000
	1,817	$117,090,000

Pulp and Paper Industry

The pulp and paper industry to date has primarily stressed waste abatement through improved process efficiency in its approach to pollution control. Significant sums of money have been spent by this industry in this area and substantial reductions in waste loadings, particularly suspended and dissolved solids, have been achieved by this approach. Nevertheless, a high percentage of the pulp and paper mills in Ontario continue to be sources of serious water pollution.

It is recognized that most of these problems exist because the mills in the Province are old and pose a difficult problem in pollution control. The industry, however, is quite aware of the fact that a satisfactory pollution abatement program has to be planned and executed. Water re-use, in-plant control steps and other process innovations can help in reducing the capital outlay for external waste treatment facilities, but will not be capable of eliminating the waste problem created by this valuable resource industry.

Steel Industry

Most of the large steel-making plants in the Province have some outstanding problems in water pollution to overcome. The industry as a whole is maintaining generally acceptable control of suspended solids and oil losses. The disposal of spent pickling acids and phenolic and ammonia liquors from blast furnace coke manufacture are the outstanding problems. The technology is available to eliminate these problems, either by the use of alternative manufacturing processes, by product recovery, or the use of existing treatment methods. All of the plants have major pollution control programmes in various stages of planning or construction, and it is expected that the completion of these programs will lead to the elimination of many of the outstanding pollution problems in this industry.

Mining Industry

Waste tailings resulting from the milling of ores is the major problem in pollution control connected with the mining industry. Generally, acceptable control of this waste by means of impoundment is practised by most of the milling plants in Ontario. However, these impoundment areas are often sources of pollution of the total environment if effective measures are not taken to prevent air and water erosion by promoting the growth of a vegetative cover.

In certain instances, tailings impoundment, while effective in achieving the control of suspended matter, results in the release of soluble inorganic materials such as toxic base metals, acids and soluble radioactive materials that require further chemical treatment. Barium chloride treatment of uranium milling wastes to control losses of soluble radioactive matter is being practised at all of the operating uranium mines in Ontario. However, losses of toxic metals from base metal mining operations by acid leaching, brought about by the atmospheric oxidation and hydrolysis of sulphide ores, is a persistent and largely unsolved problem, particularly in the nickel mining areas of the Province.

Food Processing Industry

The outstanding pollution problems in the food processing industries are numerous and are associated with dairy processing, vegetable and fruit canning and meat packing plants. Generally, the wastes from these processes are of such high strength that treatment costs can often be beyond the ability of the individual plant to afford. This is further aggravated by the fact that many of the plants, particularly in the dairy processing and meat packing industries, are small.

The disposal of wastes from such plants to municipal sewage treatment facilities is very often the only feasible method of pollution control. Where municipal treatment facilities are not available, wastes can, and are being disposed by lagooning or spray irrigation. However, the use of irrigation as a disposal method is only possible during the summer months. Consequently, wastes have to be stored during the winter to make this method of treatment completely effective. Seasonal problems still exist in a number of instances where winter storage capacity is not available or is inadequate.

Ultimate pollution control appears to be centred on the ability of this industry to pay the cost. There appears to be a general trend in the industry towards consolidation into more economically sound units and hopefully, this trend will lead to more effective pollution control in the future.

Oil and Chemical Processing Industry

The oil and chemical processing industry is made up of a wide variety of manufacturing plants. Those plants engaged in the refining and manufacture of petroleum and petrochemical products have invested considerable capital funds in pollution control and this is reflected in a largely acceptable status for these plants in regard to water pollution. Biological and physical treatment systems, and/or deep well disposal of high strength wastes are common practices in this industry.

Agricultural chemical and heavy chemical manufacturing are specific industry groupings where pollution control remains unsatisfactory. Wastes resulting from the manufacture of fertilizers and heavy chemicals usually contain high concentrations of suspended solids, phosphates, and nitrogen, as well as exhibiting a high acidity or alkalinity. Sedimentation and neutralization are commonly employed to control these factors.

The presence of nutrient materials, such as phosphates and nitrates, common to fertilizers, and the presence of herbicide and pesticide residues in natural waters in the Province is becoming of increasing concern, with the result that the manufacture and use of these materials is likely to be subject to more stringent control in the future.

Plating and Metal Finishing Industry

Plating and metal finishing wastes are potentially toxic to living organisms and as such, they are subject to fairly stringent regulations regarding disposal. Plating plants located in the larger urban centres usually discharge their wastes to municipal sewers following a degree of pretreatment. Recent figures compiled by staff indicate that two-thirds of the plating plants in the Province utilize this method of disposal and the majority of the municipal plants receiving these discharges have an ability to assimilate and dilute reasonable quantities of plating wastes without carry-over to the receiving waters.

The remaining plants present a difficult problem as plating waste treatment equipment is expensive, costly to operate, and requires a degree of skilled attention which, in all too many cases, is not available it seems in this industry. In-plant controls can be effective in reducing contaminant levels in the waste flows from these plants, and when followed by some form of chemical treatment to eliminate the remaining residual levels of toxic components, satisfactory waste control can be achieved.

Tanning, Rendering and Textiles

A majority of the plants in these classifications have acceptable pollution control practices. Discharge of pretreated waste flows to municipal sewage treatment plants or land disposal of wastes by spray and broad irrigation are

employed in a number of cases. Just as with some food processing plants with currently unacceptable control, the disposal of wastes to new adequately sized municipal treatment plants being developed in certain areas of the Province will result in complete waste control being achieved by certain plants in these classifications in the near future.

Service and Miscellaneous Manufacturing

The industries in the service and miscellaneous manufacturing classification, shown in Table I, give rise to a wide variety of problems. Oil pollution at railway terminals is relatively common where refuelling and car washing are carried out. Truck transport operations present problems where tank cleaning operations are carried out. Coal-fired and nuclear generating stations use vast quantities of cooling water, and thermal pollution from these sources is being investigated. Improved control and disposal of fly ash is another problem that is being actively studied.

Summary

Of the 1,800 wet process industries under active surveillance in the Ontario Water Resources Commission's program of industrial waste control, approximately 60 per cent discharge their wastes onto the land or into municipal sewerage systems. These methods of disposal with careful operation or regulation by enforcement of local sewer-use by-laws have proven to be a satisfactory and economic means of disposal for the majority of these industries.

Of the approximate 600 industries discharging wastewaters into public waters or storm sewers in the Province, those in the pulp and paper, food processing and mining classifications make up a high percentage of the 300-plus that can be said to have inadequate waste control. Many of the industries in this category have problems that are complicated by poor location and antiquated sewer layouts and must also face a combination of technical and economic problems that prevent a pollution control program from being planned and executed immediately.

The fact, therefore, has to be faced that waste problems at a majority of the older established industries cannot be solved overnight. Commission policy requires that suitable timetables for reducing waste loads be formulated and that this be followed diligently. The reporting of steady progress and improvements in waste control as they are made can and must serve as an acceptable alternative to rigid enforcement of the terms of the Act at some of these problem industries.

With new industries locating in the Province, the terms of the O.W.R.C. Act are being applied firmly so that waste treatment and control have to be considered at the outset by industrial management.

If concern is expressed by management, pollution abatement can become an adjunct to normal operations because of its tendency to keep people employed in industry alert to wastage of raw materials and product. It has been our experience that if employees at all levels know that management wants them to prevent water pollution, there can be a dramatic improvement in simple housekeeping which is often the first big step that older industries have to implement in solving their pollution problems.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"AIR POLLUTION CONTROL AND SOME OF ITS AFFECTS ON INDUSTRY"

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The purpose of this paper is to outline in general terms the new Ontario Air Pollution Control program, and to give some indication of how this program relates to, or affects, industry. With this in mind it is intended to review the new legislation, sketch the means of its implementation, then discuss fundamental aspects of control and finally indicate the relationship of all this to industry.

Historically, air pollution legislation was originally found in The Municipal Act, but was limited in scope to smoke control. A select Committee was established to study this problem, and as a result of their 1957 report, the Air Pollution Control Act 1958 was passed. This Act delegated total control to the municipalities with the Province performing an advisory role. In 1963 this Act was amended to provide for provincial control of new industrial sources. Smoke control authority remained with the municipalities.

Financial assistance and training of the inspectors, at no cost to the municipality, were offered as inducements to stimulate activity at the municipal level. The results were, to put it bluntly, disappointing. By the end of 1966, of better than 1,000 municipalities in Ontario, some 26 municipalities had passed by-laws under the Act, while two continued to operate under the provisions of the Municipal Act. Only four municipalities had staff working full time on air pollution control. The remainder operated on a part-time basis combining it with other functions such as sign inspector, fire chief, or wherever they could find a home for it. Some municipalities passed a by-law and forgot about it.

Thus the control of air pollution at the local level was not functioning commensurate with the magnitude of this growing problem. Moreover, it was becoming increasingly apparent that air pollution was no respecter of political boundaries, either municipal, provincial or national. As a consequence the Air Pollution Control Act, 1967, was passed, whereby the Province assumed the control functions for all sources. This Act was passed in June and was proclaimed on October 26th. There is no provision in the Act for delegation of authority to the municipalities.

The salient features of the Act are as follows:

1. Authority to control new stationary sources of air pollution by requiring a certificate of approval before such new sources may be created. Also covered in this provision is the requirement for existing sources which expand or modify to obtain a certificate of approval prior to undertaking such work.

2. Authority to control and regulate all sources of air pollution through investigations by Provincial Officers and orders of the Minister of Health.

3. Establishment of an Air Pollution Control Advisory Board to review recommendations of a Provincial Officer and, after a hearing, to report with its recommendations to the Minister.

4. Authority in the Minister, after investigation, to order the discontinuance of the discharge of any air contaminant in unusual cases where such discharge creates an immediate and serious danger to the health of the public, and where a delay in following the usual procedure under the Act would prejudicially affect the public.

5. Provisions for a Board of Negotiations to negotiate the settlement of claims of persons whose crops or livestock are damaged by air pollution resulting in economic loss.

6. Authority to control and regulate the discharge of air contaminants from motor vehicles by setting standards of emissions and requiring motor vehicles to be equipped with systems or devices to prevent or lessen the emission of air contaminants.

7. Provision for the investigation of air pollution problems and for research and education programs in the field of air pollution.

A discussion of the implementation of this Act involves both the subject of timing and that of the administrative means. With respect to the timing, in order to provide for an orderly transition period from municipal to provincial control the existing municipal by-laws will remain in effect until such time as the Provincial regulation is made effective in that area. To accomplish this, regulations may be general or particular in application, and may be limited as to time or place or both.

The absorption of existing municipal operations into the provincial operation starts with Metropolitan Toronto on January 1st, 1968, to be followed by Hamilton, Peel County and London during 1968. Existing agencies are being taken over first, to provide a nucleus of trained personnel which can be used as a training base for new personnel. It is certainly not our intention to move municipal personnel around the Province. This would dilute existing programs.

Municipalities which have by-laws but no full-time enforcement will be in the second phase of activity. Those municipalities without by-laws will follow in successive phases.

This phasing applies primarily to the control of combustion sources, since the enforcement of such regulations require personnel located in the area concerned with taking daily observations.

The control of industrial sources of air pollution will proceed simultaneously since it will not be limited to specific areas, rather it will be applied on a province-wide basis. Industrial control will be on the basis of the type of industry. Operations of the same type will be subject to control at the same time regardless of location. However, there are two important modifications to this. First, any new operations or modifications to existing operations are required to obtain approval with respect to their air effluents prior to construction. Second, any existing operation may be subject to a survey and the Minister's order, to abate air pollution affects ahead of regulations for that industry.

Turning now to the administrative means of implementing the Air Pollution Control program, it can be noted that the control of air pollution is essentially an engineering function, which is assisted by other disciplines such as medicine, plant pathology, veterinary science, meteorology, and so on. All of these sciences must work together in order to resolve the universal problem of air pollution. For this reason the Head Office of the Air Pollution Control Service is composed of the following sections: Abatement, Approvals, Meteorology and Air Quality, Phytotoxicology, Vehicular Emissions, Laboratory, and Administration.

Since the primary function of the whole is air pollution abatement, each section, with its related disciplines, contributes its share to the abatement program. Each contribution is translated into effective action through the regional and district offices, and these in turn supply first-hand information concerning local conditions.

With respect to the field offices, the Province will be divided initially into seven regions. These regions are such as to take into account the economic factors, population density and health regions. With few minor exceptions, the air pollution regions will conform with those used by other Provincial departments. Depending upon the size of the regions and the economic activity, each region will be divided into two or more districts. Each region will be headed up by an engineer, as will each district. Inspectors will be located throughout the districts and their primary purpose will be to enforce the regulations concerning combustion sources and to assist the engineers in making observations and investigating complaints.

It is planned during the fiscal year 1968-69 to establish offices at Sarnia, Windsor, London, Welland, Hamilton, Oakville, Brampton, Sudbury and the Lakehead.

Perhaps it should be mentioned here that this is not the whole administrative story. In order to ensure that, in the resolution of air pollution problems, all aspects are considered and that action of the individual departments do not detract from the Provincial air pollution program, inter-departmental liaison is essential. The mechanism for this currently exists, for as you may recall, last year the Honourable John Robarts set up an Advisory Committee on Pollution Control. This Committee is composed of the Deputy Ministers of those departments dealing with resources and pollution. In addition a special sub-committee on air pollution has been appointed. The sub-committee is made up of senior staff members from the departments of Agriculture and Food, Transport, Economics and Development, Energy and Resources Management, Lands and Forests, Mines, and Municipal Affairs, under the chairmanship of the Department of Health.

Having described the legislation and the functional mechanism which is being built up to achieve air pollution control in the Province, it might be well to pause and ask just what is really meant by air pollution control? Control of air pollution implies a dynamic situation in which the air quality criteria will be modified as further research and experience dictate. Control does not mean complete elimination any more than good water means sterile distilled water. Thus, before any consideration can be given to the "what", "how" and "timing", of control, it must first be decided for each pollutant what maximum amount, or rather what maximum concentration, can be present in our atmosphere above which any increase in concentration is undesirable. It should be noted here that to speak of concentration alone is not strictly true because any chemical-physical reaction -- e.g. soiling, vegetation damage or human health effects -- depends on time of exposure as well as concentration. The term "undesirable concentration" is meaningless unless a time element is stated, or at least implied.

Since air pollution control is being forced on modern civilization by a growing awareness of a threat to man's health and well-being and activities, or to put it another way, uncontrolled concentrations of pollutants are exhibiting an

adverse effect both to man and his activities, it becomes obvious that the fundamental guide post -- the underlying concept which must be used -- in controlling pollutants is that of effects. Thus, to decide what concentration of any pollutant is undesirable, it is necessary to examine all the known facts concerning the effects of that pollutant on man, animals, vegetation and property. This study produces ambient air criteria for the contaminant. The criteria are not absolute because much remains to be discovered about many of our air contaminants. This matter will be treated in another paper.

When considering or evaluating emissions from a given industrial stack, how then, can these ambient air criteria be applied? What relationship exists between the specific emissions of a given stack and the ambient air quality in the neighbourhood? The concentrations of pollutants, once they leave the stack, become diluted or dispersed. The degree or rate of dispersion will depend on local meteorological conditions and topography. Knowing the local meteorology and topography one can estimate, to a practical degree, the downwind concentrations to be expected under varying conditions by using the diffusion formulae. Thus, if an industry is located in a valley where air movement is restricted, it would have to control its emissions to a greater degree than if it were located on an open plain with good ventilation. Or again, under normal atmospheric conditions, pollutants emitted to the atmosphere will disperse quite readily, but when temperature inversions are experienced, the concentration of pollutants builds up. The frequency, intensity, and duration of inversions thus affects greatly what the atmosphere can safely absorb. Meteorological and topographical considerations thus dictate downwind concentrations.

Having determined these factors, the effect of these concentrations then depends upon the nature of the things upon which they impinge. That is, land usage now becomes a deciding factor as to whether the concentrations are unacceptably high. It is our opinion that control parameters should be based primarily upon the effects of pollutants on human health and well-being, vegetation, animals, economic loss, discomfort and aesthetic values. In order to do this, it is necessary to control the quality of the ambient air in the context of its usage. This may be done by using ambient air quality criteria and taking into account the local meteorology, topography and land usage to arrive at allowable emission rates. In actuality, this means that similar operations may be permitted to emit different amounts of pollutants depending on location.

I would point out that there are certain instances where, in our opinion, emission standards, as opposed to ambient air criteria, are both logical and desirable because of technology and multitude of sources. I refer now to the use of the smoke density chart for combustion sources and standards for automobile emissions. It is also probable that, because of similar considerations, multi-small sources such as paint spray booths, small grinders and the like will be subject to equipment standards. It is also true that an area approach may have to be taken, particularly in large metropolitan areas, with respect to certain common contaminants such as SO_2 and oxides of nitrogen. This would result in fuel specifications and/or equipment specifications.

What does all this mean to industry? Broadly speaking, it is at once potentially restrictive and fundamentally challenging. It is the sort of challenge that private enterprise meets best. There is a need, and satisfying that need opens up new ideas and new processes.

As a first step it should be the business of each firm to know what its air effluents are, not simply qualitatively but specifically, in kind and quantity. The second step is literally to design the effects of your effluents so that they are commensurate with the dispersion conditions and land-usage of your neighbourhood. In these two steps the considerable resources of the Air Pollution Control Service are at your disposal. And third, no matter how good is the design of your equipment and processes from an air effluent standpoint, there are still the human and operational factors. This means an educational program among the firms' employees -- plus realistic supervision. The beneficial effects of attention to air pollution as an integral part of good operations cannot be over-emphasized and is particularly evident at times of process upset conditions.

The addition of an air pollution parameter to industrial operations will, because of economic factors, produce some, if not all, of the following effects on industry itself:

1. It will be a factor in the choice of processes used and in the selection of raw materials.

2. It will certainly effect equipment design. For one thing, more attention will be paid to minimizing the air exhausted to atmosphere, particularly if this air must be treated before exhausting. This in turn affects such things as hood design, duct design and fan horsepower.

3. Serious attention to the nature and amount of material now exhausted to atmosphere can, and frequently does, lead to an improvement of process efficiency and/or the economic recovery of what is now a waste product. This can be exemplified even in such unlikely areas as odor control of solvents.

4. Because air pollution control cannot be considered apart from meteorology, topography and land usage, air pollution factors now rightly become important in the selection of location for a given process.

5. Air pollution control will have an effect on all phases of the equipment supply industries. First because there will be increasing demand for exact engineering as opposed to "off-the-shelf answers", and second, there will be accelerated competition for new and better ways to achieve the desired degree of control.

You will note that the program as outlined is in the context of today's technology. It is our firm belief that if we are to achieve any real success in the control of air pollution it will not be by hanging things on existing equipment but rather by the development of new processes which do not evolve pollutants. This is the real challenge to industry for the immediate future.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"SOIL POLLUTION CONTROL"

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The opportunity to address you today is a stimulating challenge. There is mounting concern over environmental problems associated with present practices of so-called solid waste disposal. This is succinctly stated in a quotation from Report No. 367 of a World Health Organization group: "failure to deal satisfactorily with the never-ending flow of solid wastes constitutes a clear threat to public health and contributes to air, water and soil pollution, as well as to the propagation of flies, rodents and other vectors of disease. In spite of this danger however, achievements in the management of solid wastes are small, when contrasted with the advances made in the treatment of waste water."

In Ontario, I consider that we can take some comfort from the effort which the Province is putting forth. Not long ago, I read a report, indicating that there are only thirteen States in the Union which are devoting the full-time activities of one or more specialists, to the problems of refuse control, and only five which are applying the services of more than one individual. Today, in the Waste Management Section of the Department of Health, we have three engineers and the program will expand.

You will observe the neat gradation in the evolution of our interest in environmental management in the order of the topics on the program. Of course, while I readily admit to the historical perspective, I hasten to add that I do not necessarily agree that low man on the program is any indication of the significance of land pollution in our plans -- nor is this implied. The really important event, is that we are looking at all segments of our environment in one context. This is as it must be, and we need to condition our thoughts and actions to avoid the temptation to work in an insulated compartment. True conservation will not permit protecting one element of our environment, while heedless of the effect on another. Similarly, it is hardly possible to segregate industrial waste problems from municipal and agricultural. There is much inter-play and many grey areas, so I will have to begin by painting with a broad brush, and endeavor to fill in with detail from time to time.

Public concern with problems of refuse disposal, onto or into land, has expanded to legislative action, as expressed in the recent addition of the new Section 95a., to The Public Health Act, and as this is the authority for all of our planning, it is fitting that I take some time to endeavor to interpret the will of the Legislature, insofar as this Section is concerned.

The basic intent is to provide general control throughout the Province of the disposal of wastes onto and into land whether the route be via landfill, incineration, composting or other method. It is not proposed that the Provincial Government assume any direct responsibility for disposal, but that a system of uniform regulations and standards be established, and enforced. These will be applicable to all types of wastes and disposal systems, which are not now covered by provincial legislation. For illustration, the Section will not include sewage which is processed in sewage treatment plants. It will, however, provide for land disposal of hauled sludge, as well as all forms of liquid and solid wastes, other than sewage, which are deposited on land. Nevertheless, as I have mentioned earlier, there are certain grey areas, and in this complex modern world it does not seem possible to draw straight lines of containment. Accordingly, we see some modifications to this approach. For example, in mining operations, it is not proposed to control the management of waste rock dumps, nor the disposition of mill tailings. This latter activity is closely aligned with water and has long been a concern of the Ontario Water Resources Commission. So where this conditions prevails, the provisions of Section 95a., will not be applicable.

There are other areas in which we shall do all that is possible to avoid overlapping jurisdictions. In the field of liquid wastes, there has been some progress towards abatement of pulp and paper mill discharges, under the stimulus of the Ontario Water Resources Commission. There are wastes which have customarily been dumped into watercourses, and are of real concern to the Commission. The provisions of Section 95a., will only come into play where solids or liquids extracted from these wastes, are considered for disposal into land, or for incineration.

In somewhat greyer hue, lie the problems of the milk processing industry. However, here again, due to the juxtaposition with watercourses, the Ontario Water Resources Commission has been instrumental in promoting considerable progress, and it is not our intent to create duplication. A similar situation is apparent with respect to treatment lagoons, which have been developed for agricultural wastes. In summary, we might say that the regulatory activity of the Department of Health, will stop short of wastes which flow in pipe or ditch in aqueous solution or suspension to a point of treatment and discharge of effluent.

A difficult area which I will only mention lies in the agricultural field. I refer to the recent development of very large poultry and livestock feeding operations. From our investigations, I am inclined to call these agricultural industries, rather than farms. The output of wastes from all livestock production is staggering, amounting to over 33 million tons annually in Ontario. Traditionally, this may usefully be absorbed as a soil additive, but the tail cannot wag the dog, and there are upper limits to the absorption. Unfortunately, the majority of these establishments do not have the land required to dispose of their wastes by the traditional and sanitary methods. It will be necessary to bring these under the regulations, and strenuous efforts are being made to find new and effective methods of disposal.

Returning to the overall problem, the primary method of control will be through licensing of all disposal sites on land, and it will be unlawful to dispose of wastes other than at a licensed site. An exception will be made for an individual disposing of household wastes upon his own property. Upon application, a certificate of approval may be issued by the Department of Health, which will be valid for one year from date of issue. If a site is considered to be unsatisfactory, but capable of improvement to an acceptable standard, a provisional certificate of approval may be issued, under stated conditions, for any given period, not exceeding one year. Needless to say, renewals of certificates may be granted on application. It is also worthy of mention to say that this is not a revenue raising program, and there will not be any fees assessed for issue of certificate.

The legislation requires posting of a financial guarantee of performance in the case of disposal sites operated by other than a municipality. The purpose of this is to protect the public against the possibility of expenditure of public funds, to rectify, or restore a site which may be abandoned in advance of orderly closing. This guarantee may be in the form of a performance bond, or a deposit of cash or suitable securities, with the Provincial Treasurer. The details will be set forth in the regulations, and it is proposed that the basis for calculation be the following:

1. Landfill Sites - $8,000 for each acre in active operation for deposition within any part of the year.

2. Incinerator Sites - $5,000 or $60.00 per ton of rated daily capacity, whichever is greater.

3. Composting Sites - $20.00 per ton of rated daily capacity.

A further clause of significance is the requirement for public advertising in the press, of intention to establish, or enlarge, a disposal site. This is to be carried out for three successive weeks, and is, of course, designed to crystallize any significant local objections in advance of the event. It is anticipated that there will be provisions to arrange a public hearing, if, in the opinion of the Minister, this appears to be desirable.

You will appreciate that it is a considerable undertaking to inspect and classify all present operating sites. These include landfills of various categories, ranging from the open dump to true sanitary landfill; incinerators; composting establishments, and possibly others. A beginning has been made and some months ago a questionnaire was circulated to all Health Units, Departments of Health, and Medical Officers of Health. On the basis of the returns, we have prepared a summary and a few projections, and I am happy to report that even at this early stage, it appears that the state of disposal in the Province is not by any means all bleak and unsatisfactory. We estimate that the total number of municipal sites will be of the order of 1,500. We have returns, reporting on conditions of sites which provide for 78% of the provincial population. Examination of these, yields information which is available for the first time in Ontario:

Disposal Site Category	Per Cent of Total Number
Open dump	50.5
Modified landfill	16.8
Sanitary landfill	27.8
Incineration	3.5
Undisclosed	1.4

Condition of Operation	Per Cent of Total Number
Satisfactory	42.0
Unsatisfactory	36.6
Closed	11.1
Undisclosed	10.3
Reports of Open Burning	52.4

Directive Organization	
Municipal	60.0
Contract to municipality	9.4
Private	9.9
Commercial	4.8
Undisclosed	15.9

You will observe that the number of private or industrial sites is small, and I am quite certain that the figures are much below the true situation. The health officers are constantly in touch with the municipal authorities, but their contacts with industrial operations are limited, and unless there are complaints they have little interest, or need, to concern themselves with private waste disposal activities. This of course, will now change. In the meantime, there is authority for granting provisional certificates of approval to permit an orderly progression of control, and the continuing operation of existing sites.

As it is apparent, the program is not directed solely to the problems of municipal refuse disposal. It is equally applicable to the industrial segment, and as I have indicated it has some implications for the agricultural community. In the industrial area, I am certain that we shall find difficulties and grey areas, but it is our intention to approach the problems sympathetically, yet with firmness when needed, and I hope that with goodwill and understanding, the problems will be resolved to the enduring benefit of later years and future generations.

As a starting point, we are faced with the need to obtain reasonably accurate information and statistics, on the quality and the quantity of the wastes generated by every class of industry. Remarkably, little is known along these lines generally, and nothing on a statistical basis. Predicated on some very coarse assumptions, we have estimated the probability that in the more urban areas, the volume of industrial waste represents a further addition between 45% and 78% of the municipal generation. If we accept a median of 60%, we see about 3,600,000 tons added to the municipal load of about 6,000,000 tons per year. In the case of municipal wastes, we can take it for granted that the composition will not vary to a serious degree from place to place, and season to season. On the other hand, the point that industrial wastes vary tremendously hardly needs to be labored. It is, therefore, of the greatest importance that we develop a reliable system for obtaining statistics on industrial waste generation, in both quality and quantity. I understand from my reading of progress in combatting water pollution that industries have frequently been loath to divulge information on waste products, in the event that competitors may obtain useful information. I hope that we have progressed to a maturity where this fear no longer exists, or that we can satisfy individual enterprises that their confidences will be protected.

If we are to develop a program which is both effective and equitable, I believe that it will be necessary to foster and encourage channels of communication and discussion, which do not exist at present. Waste management is a problem which affects everybody directly or indirectly. It is also one which is really of area or regional concern, and transcends municipal boundaries. This is particularly the case with industrial wastes and hence we require forums where area solutions may be considered. It may be that there are suitable organizations in existence, and if this is the case, I hope they will come forward. Failing this, I commend the formation of groups along the lines of the Lambton Industrial Society. This, under the original name of the St. Clair River Research Committee, was the pioneer co-operative industrial group concerned with problems of environmental pollution.

It was certainly the first in Canada, and probably the first on the Continent. The inaugural meeting, involving just three companies, was held during February 1952. By 1955 there were ten members and an appreciable amount of investigative work was in process, using the agency of the Ontario Research Foundation to an extensive degree. At this point, it should be emphasized that the Committee was solely technical, both in make-up and jurisdiction -- it had neither responsibility nor authority, to speak for the member firms in matters of policy. Since those early days, the work of this pioneer organization has gained general recognition and similar groups, such as the Laval Industrial Association in Montreal, have been formed.

The value of such an organization, for consideration of mutual problems and in particular, communicating with government agencies, has been recognized by industrial management and government administrators.

Finally, following natural development, the Lambton Industrial Society has evolved. It was incorporated March 16th, 1967 under provincial charter, and is directed by senior management representatives of the twelve major industrial complexes in the Sarnia area. The objective as officially stated is "to promote joint and individual effort by member industries in fields of education and research to achieve control of industrial pollution of air, soil and water, consistent with government regulations and good corporate citizenship."

Insofar as waste management is concerned, it is not proposed that an association, such as Lambton Industrial Society be a replacement for dealing directly with single firms on individual problems, but this approach does offer an ideal platform for dealing with matters of common interest and in developing the area approach.

This is illustrated in the rather long drawn-out investigations and complex patterns of disposal of chemical wastes in the St. Clair River Valley. As a result of rather spasmodic joint action, a facility was established near Corunna about nine miles south of Sarnia to dispose of difficult chemical wastes. The facility is operated by a private contractor who executes agreements with various firms. Without going into detail, it suffices to say that the operation grew like Topsy and became quite out-of-hand. Investigation clearly indicated the advantages of continuing the concept of a single facility, serving the needs of the area industries, but without the existing coalescing influences of the Lambton Industrial Society, it is likely that joint effort would have foundered, and each industry left to its own devices. As is now indicated, it is likely that a private operation providing both incineration and landfill to contract customers, and operating under The Public Health Act and the Air Pollution Control Act, will be established to serve the needs of this highly industrialized area. This will undoubtedly be another first in Canada. It is hoped that other similar approaches may follow soon, as the need for controlled disposition of industrial wastes in other areas is quite apparent.

As I have mentioned earlier the regulations are in process of preparation. The legislation is clear, in that it will be unlawful to deposit waste other than at an approved site. In the case of an industry, this raises the problem of what is a waste disposal site? It is fairly obvious that regular or intermittent deposit of wastes in appreciable volume will be required to be brought under control. Also, even relatively small volumes of hazardous material must submit to regulation -- but what of small quantities of innocuous materials? It is not our intent to establish a rigid bureaucratic control to hamper industrial or commercial initiative, but in this instance the establishment of effective criteria appears to be troublesome. However, it should be noted that the Minister has authority to classify waste disposal systems, and waste disposal sites, and to exempt any from the provisions of the Section, or any part of the regulations.

Earlier I have outlined that we have very little information on the amount of industrial waste, yet from limited surveys we know that it is large. The MacLaren report estimates 434,000 tons, including 19 million gallons of liquids, generated in Metro Toronto. The disposal of these large volumes gives cause for considerable concern. In the main the disposal sites are not known and there is doubtless considerable hazard attached to many of them. In many instances throughout the Province, the municipal authorities will not accept industrial wastes at the public facilities. In the past, of course, many of these have disappeared into the nearest waterway, but the vigilance of the Ontario Water

Commission is rapidly checking this practice. With the compelling need to get rid of these wastes, and with no facilities on the property, I am afraid we must admit that much is handled by means of a contract hauler, and no questions asked. The hauler, while executing an essential function, is frequently chevied and harried from one possibly illegal site to another, by officers of a Health Unit, for lack of any approved facilities.

The situation must change and a responsible attitude be developed in all parties. In the first instance, if a municipality is agreeable to welcoming and accepting an industry, it must be prepared to ensure that there is capability in the private or public spheres -- or both -- to safely, and adequately, stabilize the wastes which will be generated. Industry of course, must do its part, and effective planning for disposal of all wastes, must be accepted as an integral part of manufacturing. With the increasing complexity of our industrial machine there is probably an active role for senior government, and I return to the area concept. It may well be that there are industrial operations, essential to our progress which may produce highly sophisticated and difficult wastes which are undesirable to handle at the local level. Under these circumstances, it may be desirable to establish a certain number of disposal sites at strategic locations where conversion, neutralization, or other disposal can be carried out under the direct supervision of well qualified engineers.

Such an outcome may well fit into our experimental and research activities. There is a great dearth of factual and accurate information on the mechanisms of waste stabilization, and we contemplate an extensive program to evaluate the effect of soil composition, and time relationships on the degradation of refuse. This is work that cannot be undertaken in the laboratory, and will involve the use of full-scale disposal sites. We intend, with the concurrence of the owners, to participate in several operations on the basis of using them in part as experimental establishments. These will involve a cross-section of typical Ontario conditions to the greatest possible degree. By means of extensive and systematic monitoring of the products of decomposition, we expect to develop a background of data. This will permit the development of criteria to enable us to forecast the probable performance of a proposed site with reasonable accuracy. The monitoring will include solid, liquid and gaseous decomposition products.

On looking forward to a rational expansion of these plans, I can foresee the likelihood of the experimental operations being expanded. Hopefully, they will provide a specialized disposal service for unusual and exceptionally hazardous wastes, such as cannot be effectively and safely handled at a conventional site. At the moment this evolution is speculation, but we shall certainly be prepared to carry out experimental work on aspects of disposal which will prove of value to industry.

On approaching my conclusion, I wish to focus our attention for a few moments on some of the broader and more philosophical aspects of our waste disposal problems. First and foremost, we have the truism, that, with relatively insignificant exception, we consume only energy. Unthinkingly, we are inclined to accept that we consume food, gasoline, coal, and all the myriad products of our civilization -- but we do not -- all that we do is convert them to something else, and this, chiefly waste. So if we visualize all of our mighty production machine, busily turning out material for the refuse dumps, the picture, while somewhat bleak, is substantially correct.

Look at some of the annual statistics, and this time I am quoting from United States figures -- automobile production, 11 million with annual scrappage at 6.8 million; automobile registrations, 90 million (comparable Canadian figure, 7 million); metal, beverage and food containers, 48 billion (more than 250 per person); glass bottles and jars, 25 billion (135 per person).

It does not seem to me to be unreasonable that the manufacture of goods should be expected to assume a portion of the responsibility for their ultimate disposal. This is similar to the concept of waste water treatment, that under the prodding of the Ontario Water Resources Commission, now appears to have gained general acceptance. While not wishing to unduly labor the situation with respect to automobile hulks, it is worthwhile to observe that Great Britain has recently passed the Civic Amenities Act. In Part III, this measure requires local authorities to provide facilities for disposal of old vehicles. Coincidentally, several gigantic plants of the Newell type have been erected. These giants will shred bodies at the rate of fifteen seconds a car, and reduce 4.4 million pounds a week to clean, segregated scrap. This is disposal allied with reclamation, which should be our objective.

Finally, I will leave the observation with you, that there is little hope of our waste management being anything other than a poor expedient, akin to sweeping litter under a rug, until we accomplish two objectives -- firstly, through the incentive of the market-place, or legislative compulsion, re-direct more material back into the economic stream, by salvage; and secondly, incorporate features, leading to chemical or biological degradation into the design of many of our products.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"THE PROVINCIAL AIR POLLUTION CONTROL PROGRAM AS IT RELATES TO THE MUNICIPALITIES"

MR. T. W. CROSS, ENGINEER,
AIR POLLUTION CONTROL SERVICE,
ONTARIO DEPARTMENT OF HEALTH.

As the title would indicate this paper will endeavor to inform you as to how the Provincial Air Pollution Control Program will be applied at the municipal level. The Government of Ontario believes it is necessary that you know what is being done, what is going to be done and what prospects the future holds. The items to be reviewed today include:

1. Legislation -- Past and Present;
2. The organizational structure to implement the Program;
3. The timing of the Program;
4. Method of controlling industry;
5. The services to be rendered to the community; and
6. The outlook for the future.

Legislation

Originally air pollution control legislation existed under the Municipal Act in the form of smoke control only. In 1958 the Air Pollution Control Act was passed placing the control of smoke and industrial air pollution in the hands of those communities who wished to pass a by-law. The Province remained in an advisory capacity. Financial assistance and training of inspectors at the expense of the Province were offered as inducements to stimulate activity at the municipal level. The response from the municipalities, to say the least, was not great -- 26 of over 1,000 municipalities passed by-laws under the Act while 2 of them continued to operate smoke by-laws under the Municipal Act. Only 4 municipalities retained full-time air pollution control staff. The remainder either forgot their by-laws or put them into the workload of employees who already had other primary functions.

In November, 1964 an Ontario regulation was written under the Act requiring applications for approval by the Province covering construction of new industrial sources or alteration of existing sources.

Faced with the lack of response from the municipalities and faced with the fact that air pollution was increasing, the Province had no alternative but to take over complete control. Such is the intent of the Air Pollution Control Act of 1967, which was passed in June, and proclaimed on October 26, of this year.

The pertinent features of the Act include:

1. The authority to control new stationary sources of air pollution by requiring a certificate of approval before any new sources may be created. Also covered in this provision is the requirement that existing sources, which expand, alter or modify, must obtain a certificate of approval prior to undertaking such work.

2. The authority to control and regulate all sources of air pollution through investigations by provincial officers and orders of the Minister.

3. The establishment of an Air Pollution Control Advisory Board which will review recommendations of a provincial officer and, after a hearing, will report its recommendations to the Minister of Health.

4. The Minister has the power, after investigation, to order the discontinuance of the discharge of any air contaminant, in unusual cases where such discharge creates an immediate and serious danger to the health of the public, and when a delay in following the usual procedures under the Act would prejudicially affect the public.

5. The provision for a board of negotiation to arbitrate the settlement of claims of persons whose crops, or livestock are damaged by air pollution and who, through this damage, have suffered economic loss.

6. The authority to control and regulate the discharge of air contaminants from motor vehicles by setting standards of emission and requiring motor vehicles to be equipped with systems or devices to prevent or lessen the emissions of air contaminants.

7. The provision for investigation of air pollution problems and for research and educational programs in the field of air pollution.

The Organizational Structure to Implement the Program

So much for the Legislation -- and now for the organization to implement this expanded Act. The control of air pollution is essentially an engineering function -- but the work of the engineer is based on a wealth of criteria supplied by the medical profession, meteorologists, plant pathologists, veterinarians, community planners, chemists and practically any other branch of the sciences you would care to name. A well-balanced program must take this into consideration and we feel our program does. The Head Office in Toronto will include the following sections:

Administration: The function of this section is obvious, of course. The aim of a centralized administration will be economy and equality of application of pertinent administration across the organization.

The Abatement or Control Section will supervise and assess the operation of the control programs being carried out in each Region. This will be more fully appreciated when we come to the description of field operations.

The Approvals Section will pass judgment on the pollution potential of all new or modified stationary sources of air pollution. Control equipment will be assessed and emissions will be weighed in the light of all available technology. This section will be responsible for a continual upgrading of the knowledge of air pollution and the techniques of controlling it. The Approvals Section will work very closely with the Abatement Engineers across the Province to judge the degree of correlation between the design of a system and its subsequent performance.

Air Quality and Meteorology: This is the Section that, among other things, will tell us whether we are winning or losing. The network of sampling stations will keep us informed as to significant changes in the air quality of our Province. The parallel network of meteorological measuring devices will enable our experts in this section to explain and/or predict our air quality problems. A knowledge of the weather parameters in an area is essential in predicting the impact of additional sources of pollution.

Municipal Planning and Zoning: This will be an advisory function to help municipalities take air pollution into consideration when they are planning zoning.

Chemical Laboratory: Here the results of the sampling network will be analyzed and calculated. Tests will be run on samples of air pollutants and vegetation or other materials damaged by air pollution.

This section will calibrate new sampling instruments and test-run them before they are put into operation in the field.

Phytotoxicology: This is the section in which the relationship between air pollution and damage to vegetation will be researched and evaluated.

Automotive Emissions: As you know, air pollution control equipment will be required on the 1969 model year production of automobiles sold in Ontario. This section will be charged with the responsibility of setting up spot check performance tests on the equipment as sold. Complete and regular testing is not presently contemplated due to the high cost involved. Test data and research will determine what future requirements in this field will be.

Information: Some of the misunderstanding about what the Government is doing with regard to air pollution is, perhaps, due to the lack of communication. It is hoped that conferences such as this and an effective Information Program will eliminate misinformed criticism. We have a responsibility to communicate with the public. This section will endeavor to see that pertinent information, in its proper context, is available.

Another asset in the fight against air pollution, which is available to Head Office, but not part of it, is the

Pollution Advisory Committee set up by the Hon. John Robarts last year. This Committee is composed of the Deputy Ministers of those departments dealing with resources and pollution. The Sub-committee on Air Pollution is composed of senior staff members from the following departments:

Agriculture and Food,

Transport,

Economics and Development,

Energy and Resources Management,

Lands and Forests,

Mines, and

Municipal Affairs.

This sub-committee is under the chairmanship of the Department of Health. Its job is to correlate the actions of the individual departments to avoid detracting from the Air Pollution Control program at the same time considering the total effect of the program on the operations of the other departments.

From the brief description of Head Office it is evident that we will have a diversified technical staff to back up the people in the field.

However, Head Office is only the place for Headaches -- the action has to take place across the Province in the municipalities and this is where the Abatement Officers will be located. The Province will be divided into 7 Regions each of which will be headed up by a Regional Engineer. Each Region, will be divided up into Districts -- the number of which will depend on the relative size of the region and the degree of industrial activity in the region. It is presently intended to divide the Province up as follows:

No. 1 Region will be Western Ontario with an office at LONDON. It will comprise District Offices in London, Windsor and Sarnia.

No. 2 Regional Office will be in HAMILTON. The District Offices will be in Welland, Hamilton and Kitchener.

No. 3 is the Metro Region and this area will be a complete region with offices in TORONTO.

No. 4 is the Central Ontario Region with offices in TORONTO. District Offices will be in Oakville, Brampton and Barrie.

No. 5 is Eastern Ontario with the office at KINGSTON and District Offices in Kingston, Ottawa and Peterborough.

No. 6 is the Lakehead Region with the office in FORT WILLIAM.

No. 7 is the Sudbury Region with the office in SUDBURY.

Each District will be headed by a District Engineer. Inspectors will be located throughout the Districts. Their duties will consist of enforcing the regulations governing smoke from the operation of combustion equipment and the observation and reporting of air pollution from other sources. The duties of the District Engineers will be to:

1. Carry out an emission survey of all sources of air pollution in the district;

2. Survey sources of industrial air pollution and meet with management of the industries involved to secure abatement of the particular problem;

3. Feed back to Head Office, the particular needs of the community in new Approvals and in Abatement Programs;

4. Liaison with the community in all matters affected by or affecting air pollution and its control;

5. Follow up with industry to see that pollution control equipment is properly installed, maintained and operated; and

6. Securing the help of any of the specialized sections at Head Office to find the answers for the problems of the municipality they are in.

The Timing of the Program

It is intended to absorb those municipalities with existing air pollution control staff first. Until the new regulations become effective in an area, any existing by-law will remain in force.

On January 1, 1968, the existing municipal operations of Metropolitan Toronto will come under the Province. During the fiscal year 1968 to 1969, the air pollution control operations of Hamilton, Peel County and London will be absorbed. At the same time offices will be established at Sarnia, Windsor, London, Welland, Hamilton, Kitchener, Oakville, Brampton, Sudbury and the Lakehead. As an area is absorbed, regulations will be written replacing the municipal by-laws in that area.

Method of Controlling Industry

As rapidly as possible, regulations will be written covering the operations of specific industries. These regulations will cover industry across the Province so that the competitive position of companies within the industry will not be impaired.

As these regulations are formulated, discussions with industry will be held to be sure that regulations are workable but, at the same time, effective in the control of air pollution. Another aim of discussion will be to get the industries looking at their whole process picture to see whether basic changes in processes will secure air pollution abatement at the same time as the processes are updated.

Services to the Municipalities

Perhaps the most basic question we can answer is "What will the Province do that the Municipalities did not, and possibly could not, do for themselves?"

1. We will provide an equality of legislation across the Province that municipal control could not give. Having one Act with pertinent regulations effective right across the Province, eliminates the possibility of an uncontrolled municipality drawing industry away from a rigidly controlled area.

   Good supervision of field personnel by Head Office staff will ensure equal application of the regulations across the Province.

2. We will back up our field personnel with specialized experts of a calibre unlikely to be available to a municipality.

3. Having our own people right in the district will ensure that they are thoroughly familiar with local conditions and will be able to operate efficiently in the locale utilizing the special services available from the Head Office.

4. Head Office will have the latest information on all aspects of air pollution and its control. We already have a Recordak system of informa-

tion on film and an extensive library of publications of all kinds.

5. One program across the Province affords more rapid adaptability. As the results of our program are evaluated, changes will undoubtedly be necessary. These changes will be more readily fed through one organization.

6. While regulations will be equal across the Province, emissions allowed in an area will reflect the existing presence of pollutants in the air.

The Outlook for the Future

No matter how you cut it, the outlook for the future is spelled W-O-R-K. This is an ambitious program and, we feel, a realistic program. We have adopted what has proven useful from programs in other countries and have added the particular needs of the municipalities that make up the Province of Ontario. Time alone will tell whether we are right. However, one big asset, which cannot be demonstrated until the time comes to use it, is flexibility. This is a mental attitude that is, and will be, built into the Service. Because knowledge of the effects of air pollutants and the control of air pollution is not complete, we know in advance that we have to be prepared to ADAPT as we find that some aspects of our program are falling short of their objective. As knowledge expands our objectives will undoubtedly have to change.

Our particular needs, at this moment are:

1. People -- qualified people. Our recruiting program is under way. Our success in securing the people we need will, in some measure, be spelled out by our ability to compete with industry for the people required. Some of these people will come from the municipal organizations coming into the Service.

2. Concern and Co-operation of both the public and those responsible for air pollution emissions. Objectivity is an absolute necessity. The control of the pollution production capability of industry in no way negates our realization of the value of industry to the high standard of living enjoyed in Ontario. Industry must be allowed to use our air resources -- but the air must be returned in a safe, useable form to the public. Our aim has to be TO CREATE something without destroying something else. This attitude needs to be reflected in all those coming into contact with us.

We have a long way to go -- much to be learned -- much to be done.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"PROVINCIAL PLANS ON LAND POLLUTION

BY MUNICIPAL WASTES"

MR. COLIN MACFARLANE,
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It has been estimated that, exclusive of land costs, the people of Ontario spend about 30 million dollars annually to have household wastes collected and disposed. This means a yearly average operating cost of about $3.60 per capita. In the main, it has been a poor bargain.

It has been so because it enjoys the same social status as a vaudeville joke -- rather dirty and barred from conversation in the home. This stigma has produced the attitude that municipal wastes should be removed at the least possible cost to places where they least offend the senses, and where they may be quickly forgotten. Unfortunately, it has also caused us to avoid looking too deeply at the consequences of our apathy until the very magnitude of the amount of waste produced demands that the problem can no longer be ignored. For example, it is estimated that Metropolitan Toronto has to dispose of approximately 1,120,000 tons of refuse each year. In 20 years time, the amount is expected to double. The total wastes, including solid wastes collected from industry, are likely to exceed 3,000,000 tons in 1986. At these levels, the vaudeville joke falls flat.

I should now define the reasons for concern in the matter of municipal waste disposal and set them in their context with land pollution.

Probably the most obvious consequences of disposal areas, in the form that they occur in Ontario, is the reduction of land values. This may stem from a number of causes, some of which are the undesirability of living close to a disposal area due to foul smells, the presence of rats and flies, and the difficulty of building on filled land. These results are bad enough in themselves, but the matter goes much further to involve the health of the public, and it is here that land pollution takes on a much more sinister aspect. We may be tempted to accept land devaluation as the price to be paid for the convenience of ridding ourselves of household wastes, but the convenience cannot extend to the point of jeopardizing public health.

Potential health hazards arise from two sources. The first is associated with the disposed material itself; the second is from percolating water discharging from the wastes.

Where wastes containing food scraps are not quickly covered with soil, there is always some risk that disease-causing microbes, which are always present in decaying food, may be blown by the wind towards dwellings. But much more serious potential sources of disease are associated with rodents and flies that find ample food and shelter in garbage dumps. Flies have been known to migrate over distances of 13 miles, and because the fly population on the surface of dumps has been found to be as high as 100 per square yard, it will be readily appreciated that the risk of pathogenic bacteria being carried by flies to humans is high and not localized. Partly due to these facts, it has not been possible to measure the degree of hazard to public health that a waste disposal site poses. However, I believe that there can be no question of the fact that the potential hazard exists and all the indications suggest that it may be high.

The other significant source of hazard stems from the percolation of water, such as rainwater, that passes through wastes and gathers available disease-causing microbes and chemical substances. This contaminated liquid may find its way to surface or ground waters and cause their pollution. If

domestic supplies are drawn from these sources, the results could be serious if the concentration of the contaminants is sufficiently high. This suggests that it is necessary to be able to predict with reasonable accuracy the events and their probable consequences that are likely to occur when a contaminated percolate is available in a waste deposit.

The present state of knowledge concerning the public health aspects of disposal is far from complete, but it is sufficient to give the clear impression that a lot more attention must be paid to the selection of disposal methods and disposal sites than they have been given in the past.

To produce a more unified approach, the disposal of municipal wastes will soon be controlled by the Ontario Government. The amount of control has already been published, in general terms, in Section 95a of the recently amended Public Health Act applicable to the Province. The detailed requirements will be made clear in the supporting Regulations which are presently being drafted. When these are proclaimed, their provisions are enforceable.

The parts of the Act that are of greatest interest are probably the sections dealing with the licensing and bonding of disposal systems. Because performance bonds do not apply to municipal governments and the details that affect private hauliers are contained in the as-yet unpublished regulations, I will not discuss the matter further. On the other hand, some discussion of the licensing of sites is necessary.

The condition of disposal areas in the Province ranges from good to very poor. The point of the licence is that it will be issued after an appraisal by the Department of Health of the proposed disposal operations outlined in each municipal application. The licences will be issued conditional upon the standards stated on the licence being met. For badly operated sites, this will usually mean the demand for specified improvements to achieve the quality required by the Department. For a well operated site, it may be that the licence will be issued on the basis that the existing standards be maintained.

Each site must be judged on its own merits. This not only turns on questions of how the site is operated, but also on its locale and the population density of the area at hazard.

At first glance, this seems to imply that the Department of Health intends to perform merely as a regulatory body to enforce the provisions of the Act. This in itself may be commendable in achieving a generally higher and more uniform standard of performance. However, it also implies that the Department shall discover the best methods of waste disposal for any given area within the Province. This not only affects public health, which must be paramount, but also economics which cannot be ignored.

It must be understood, however, that there are no generally agreed "best" methods of waste disposal. This is partly due to the fact that it is a new and developing science, and partly due to a failure to agree on methods of assessing true costs. The latter aspect includes such thorny problems as land valuation as contrasted with land costs, the influence of the hidden costs of cleaning up polluted water, and the loss of resources materials such as paper, steel and plastics. It looks certain that, for some time to come, all methods of disposal will be open to criticism on economic grounds, but the trend seems to be that wastes are not materials to be cast aside but, rather, to be managed. That is, the future seems to hold the prospect that we must take a much harder look at salvage and re-use of our waste than has been necessary in the past.

It is also implicit that the Department shall evaluate methods of disposal such as incineration and composting. Both have much to commend them from the standpoint of public health. Also, they are potentially of value in the economic sense. However, their acceptability has been mixed. In the case of incineration, the criticism appears to have stemmed principally from obsolescence due to changes in composition of refuse over the years, and due to much more stringent air pollution control requirements. For a number of years, incinerators were out of fashion, but there appears to be a marked trend towards their re-adoption. Many of the more recent designs include steam-raising and distribution systems. The steam is sold for the heating of buildings to recover part of the cost of incineration.

Composting holds great promise as a soil conditioner in agriculture, and it presents the only disposal system that returns something to the land that is both sanitary and beneficial. However, with notable exceptions, it has never really caught the public imagination, mainly, I believe, because it has suffered from over-promotion or poor sales organization. At least in part, this may be due to a failure to distinguish between a soil conditioner and a fertilizer. On the other hand, the true role of composts may be the combination of municipal wastes with sewage sludge and those agricultural wastes that are now producing a very serious land pollution problem. If this is correct, the resulting compost will be not only a soil conditioner, but also a valuable fertilizer.

From what has been said, you may gather that the Department of Health's first task is to ensure that the risk of producing disease from disposal sites is minimal. It is intended to accomplish this end by several means. The first is by information, and particularly that information which is passed to municipal engineers and city officials who understand, often only too well, the growing size and complexity of the business of waste disposal. The public interest has been sharply awakened in the last few months, primarily due, I believe, to the excellent work of the news media. With this backing, the Department intends to implement the appropriate parts of The Public Health Act and the supporting regulations through the existing health units. However, the amount of effort involved is going to be very considerable indeed. Therefore, to supplement the health units, regional engineers and a number of inspectors will be added to the Department's staff.

Meanwhile, data are being sought and collected from many parts of the world on the effects of municipal wastes on the environment. Locally, we have started a field study of a disposal area near Toronto and more will follow. Nobody knows better than the Department how much leeway has to be made up between the practices of disposal and the state of scientific knowledge of their effects. We believe that we have gathered most of the data that are available, but more information is required. Nevertheless, though we may lack important details, the principles of good disposal are clear enough.

We will soon be in a position of accepting, modifying or rejecting proposals for disposal systems, and our judgment will be based on what we know and what the proposals tell us. This suggests that we must pass on an account of the present state of knowledge so that municipalities understand what is involved and on what we shall base an opinion. To achieve our purpose, we intend to publish an informative booklet, shortly after publication of the regulations, that will fill

in the engineering background to the legislation. In the meantime, we shall be happy to advise on matters relating to waste disposal. The advice is free and, we hope, good. Unlike many of the present waste disposal methods, this may be one bargain that is worth picking up.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"WATER POLLUTION CONTROL IN ONTARIO"

MR. J. R. BARR, DIRECTOR,
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ONTARIO WATER RESOURCES COMMISSION.

Introduction

The subject "Water Pollution Control" is a very topical one of today. While basic to the very survival of man in his environment, its importance as a whole has increased in recent years affecting not only our personal lives but also our nation's environment and prosperity.

Our ancestors settled in unspoiled land of unlimited resources -- a land easily capable of absorbing the wastes of its human population. Nourished, however, by these same resources the human inhabitants have multiplied greatly and have grouped themselves to form giant urban concentrations. In and around the urban concentrations, there has developed the vast and productive industrial and agricultural establishments upon which, in a large measure, our economy is based. This advance in development has highlighted the problem both with respect to water supply and the subject today, "Pollution Control".

In the limited time available, I will outline the basic objective of our water pollution control program in Ontario, review the immediate history of the subject, provide detail on four basic provincial programs and present some observations on future activities.

Objective of Water Pollution Control Program

It is the basic objective of the Province that its water resources be utilized wisely in the best interests of its people. This requires the restoration and maintenance of water quality for the greatest possible use. Toward this need, the provincial water pollution control program takes into consideration the use and value of water resources for the public, agriculture and industrial water supplies, propagation of fish and wildlife, recreational purposes, aesthetic enjoyment and other legitimate uses. This objective must be made in the face of the increased urban and industrial development as mentioned previously.

History of Pollution Control in the Province

I shall now endeavor to trace the problems which have developed within this Province with respect to water pollution control as direct consequence of population expansion and industrial development. In the last 20 years, the population of the Province has almost doubled and practically all this expansion has taken place in urban areas supporting industrialization.

In the late forties, the growing population demanded new housing and industry. The demand for housing outstripped the ability of municipal agencies to provide adequate new or expanded sewage treatment facilities. As a consequence, existing sewage treatment plants were soon operating beyond their capacity and extensive use was made of septic tank sewage disposal systems. In many instances, the soil conditions were unsatisfactory leading to the malfunctioning of the septic tank systems resulting in pollution problems. Industry also was seriously handicapped in providing adequate treatment facilities because of the lack of both land for the construction of septic tank systems and sewer systems capable of receiving its wastewater.

Ascertaining that large scale development on septic tank disposal systems was not fully satisfactory, a rash of temporary and small sewage treatment works were constructed in the late forties and early fifties. It was soon found that subdivision developers were incapable or not interested in adequately providing for the future operation of the multitude of small plants. Compounding the problem, municipalities were often unable to finance sewage collection and treatment works to correct the problems indicated above.

In 1955, a special investigating committee was established by the Province to look into the water pollution control and water supply situation. A number of hearings were held in various parts of the Province and a great deal of information was gathered. In 1956, as a result of the report made by the committee, the government introduced in the Ontario Legislature Bill No. 98 entitled "The Act to Establish a Water Resources Commission". The Act came into effect on March 28, 1956.

At the 1957 Session of the Ontario Legislature, the Act of 1956 was replaced by Bill No. 164 entitled "The Ontario Water Resources Commission Act, 1957", the latter Act greatly widening the scope of the Commission's program and at the same time setting out certain procedures. It transferred from The Public Health Act a number of sections pertaining to water and sewage works and it also transferred from the Department of Mines the supervision over well drilling operations. Emphasis was placed upon the construction of water and sewage projects for municipalities, and new authority was given to control the pollution of waterways with a view to conserving and developing the water resources of the Province. This legislation came into effect on April 3, 1957.

Pollution Control Program

The functional water pollution control program will be reviewed under four separate but interrelated activities:

1. Water quality surveys designed to monitor water quality and develop water quality objectives and guidelines;

2. Pollution surveys designed to detect sources of pollution and initiate corrective action;

3. Development and regulation of wastewater treatment facilities; and

4. Applied research.

1. Water Quality Surveys

The water quality surveys program is designed to co-ordinate and provide direction to the many water pollution control investigations and programs being undertaken. As previously stated, the basic objective of any pollution control program is to ensure that the water resources of the Province are utilized wisely in the best interests of its people. Any treatment works developed, is only valid as it is related to the water quality in our streams, rivers and lakes.

Investigations in the program include the monitoring of water quality in the provincial lakes and streams, and surveys leading to the

forecast of water quality under various combinations of water use on specific river basin systems.

The water quality monitoring program is designed to provide quality data on monthly, seasonal and annual variations at selected sampling points throughout the Province. This program now covers 390 stations. To augment the manually collected water quality data, one robot monitor capable of measuring 8 parameters simultaneously on a continuous basis is now in operation. It is proposed to increase the automatic robot monitor program by the installation of four additional units with telemetering to Toronto, storage on tapes, and the assessment of data with the aid of computers.

The monitoring program also includes a special radiological study of areas where problems associated with the mining and processing of uranium may develop.

The water quality analysis and forecast program is designed to define the self-purification capacity of streams in the assimilation of wastewater. Analysis of field data enables the development of mathematical models which permits the forecast of water quality variations under specific conditions of wastewater loading, water temperature and stream flows. In plain language, the program is designed to provide answers to municipalities and industry as to the degree of wastewater treatment required and where the treated waste may be discharged without adversely affecting downstream water uses. The information collected from the monitoring program and waste assimilation work must be related to water quality criteria or guidelines. At the present time, policy guidelines have been adopted for water quality objectives for Provincial waters. A committee is now working to provide minimum quality control requirements. Without the basic water quality surveys program and its relation to water quality objectives, other programs, which will be detailed later, would often be misdirected providing overly restrictive guidelines or, on the other hand, allow the degradation of our waterways even though a specified degree of wastewater treatment is provided.

In addition to the monitoring program, a special Great Lakes survey is now being undertaken in conjunction with the International Joint Commission. The program is designed to supply data on water quality conditions in the lower Great Lakes and interconnecting waters. Included in the program is a study to determine the nutrient and organic inputs. The data collected in the program will provide a basis for the forecasting of pollution control requirements of the lakes and tributary drainage basins.

2. Pollution Surveys

In all inhabited developed areas of the Province, pollution surveys have been performed by field staff of the Ontario Water Resources Commission. The surveys include the cataloguing of sewer outfalls and the sampling of any effluent waters being discharged to our watercourses. Reports resulting from the surveys are directed to the responsible authority, usually municipal, which is responsible for offending discharges, with

the request that remedial action be undertaken to re-direct the wastes to more adequate wastewater treatment facilities. As required, meetings are held with the responsible authority whereby the extent of the pollution problem is outlined and methods of solution are reviewed. The pollution survey program in itself is basic in nature. However, without this type of approach, little headway could be made in controlling water quality in the Province. The very nature of the program which includes the individual sampling and cataloguing of all wastewater discharges, provides some clue as to the great deal of work that is required in this important function.

3. Wastewater Treatment Facilities

There are two basic programs for the development and regulation of wastewater treatment facilities. One program, which will be reviewed here, is the municipal wastewater treatment function. The industrial wastes program is being reviewed at the concurrent industrial session. There are many facets in the municipal program, including the Provincial financing of individual and joint sewage works schemes, the area planning of joint works, the design approval of sewage works which are to be installed in the Province, and the routine inspection of operating wastewater treatment facilities.

The Ontario Water Resources Commission Act, 1957, greatly widened the scope of the program previously undertaken by the Sanitary Engineering Division of the Ontario Department of Health. Among other things, emphasis was placed on the financing and construction of sewage projects by the O. W. R. C., providing a solution to pollution problems, where in the past, limited knowledge and financing had restricted the installation of adequate facilities. In the first ten years of operation, 1957-1967, 225 municipal sewage works projects have been financed and constructed by the O. W. R. C. at a total estimated capital cost of $118-1/2 million. In this same period, over $900 million have been spent on sewage works across the Province.

By the year 1964, because of the acceleration in the construction of sewage works, a marked improvement in pollution control in Ontario was observed. However, there were still a number of municipalities in need of facilities which could not go forward either on the basis of their own financing or under that of the O. W. R. C. because of their inability to assume the capital debt involved. It was for this reason that the Government of Ontario in 1964 and 1965, introduced further measures whereby the authority of the O. W. R. C. was expanded to permit the construction of sewage works on the basis of permanent Provincial ownership, with the municipality signing the service contract for its sewage treatment requirements, developed on a gallonage basis. Provincial projects of this nature are now being planned all over the Province. No less than 140 Provincial sewage works projects have been accepted by the Commission to date. Two advantages of the Provincial program are the provision of deferred financing for oversizing of works designed to meet future needs, and the provision of long-term financing at Provincial borrowing rates. Also, greater flexibility is provided when a number of municipalities are served on a joint basis. This type of area approach is

most important when municipalities are located on inadequate receiving waters, requiring the use of long trunk sewers.

Realizing the importance of regional water and sewage works schemes, a new branch was established in the O.W.R.C. to report on the provision of water supply and pollution control facilities on an area or watershed basis. The studies include the review of population and land-use trends available from numerous sources to provide an insight into future pollution control requirements. It is expected that the studies performed by the Branch will be utilized as a guideline for the development of Provincial area sewage works installations. Also, guidance will be provided to areas where individual municipal action may be deemed more feasible.

One of the provisions of The Ontario Water Resources Commission Act is a requirement that sewage works being constructed in the Province must be approved by the Commission before they are constructed. This provision ensures that adequate sewage treatment facilities are provided to meet the needs of the area to be served and that the treated wastes are directed to adequate receiving waters. The extent of the approval program is indicated by the number of applications handled in 1966. During this year, 1079 certificates were issued at an estimated cost of the approved works of 107 million dollars. A further control which is provided on the development of sewage works is the approval of subdivisions required by the Ontario Department of Municipal Affairs. Before approving a subdivision, the Department submits plans of proposed development to a number of agencies including the Department of Health and the O.W.R.C. for examination. In this way, new development is directed to areas where adequate wastewater treatment facilities will be available.

When sewage treatment works have been constructed, a routine inspection program is provided to ensure that they are operated in such a way as to provide a satisfactory effluent. During 1966, 1463 routine and special inspections were made of wastewater treatment works by the field staff of the Ontario Water Resources Commission.

4. Applied Research

The O.W.R.C. is studying existing wastewater treatment facilities to devise methods of improving treatment, and examining new methods of wastewater handling.

Modifications to existing processes may possibly be made which will increase the pollutant removal efficiency of the process. An example of this is a modified activated sludge type process first carried out in the United States and now being investigated for possible application in Ontario. The process is designed to remove phosphates from sewage.

A new process unit developed in Europe has been proposed for use in small municipalities and an evaluation of it has been carried out by the O.W.R.C. prior to its acceptance in Ontario.

The O.W.R.C. investigates the application of commercially available equipment to processes for the treatment of wastewater. This has been of special interest in improving effluent treatment at existing plants.

Studies of nutrition are a prerequisite to the control of aquatic nuisance organisms and the Commission has several monitoring and research programs underway to determine the nutrient levels in our natural waters and also to determine the nutritional levels which will lead to the propagation of aquatic organisms. As part of this program, a continuing sampling routine is being carried out in the Trent Canal system to determine the extent of nutrient migration through the system. Programs are also underway to determine the source of nutrients reaching our waters.

With the determination of amounts, types and sources of nutrients, and the development of suitable removal processes, it will become possible to control algal growths by either eliminating the nutrients at their source or if this is not feasible, removing them by treatment at sewage treatment plants. This, however, is still in the future and in the interim the O.W.R.C. is carrying out programs to control or eliminate algae which now exist. These include studies of control chemicals and methods of harvesting. Both methods have been tried and on the too common algae "Cladophora" have shown promise but require further development.

Future Activities

It is evident that when dealing with large bodies of water such as the Great Lakes and the many river basins in the Province, piece-meal, short-term planning cannot ensure continuous availability of water with a high quality. The commonly accepted notion that our waters have an unlimited capacity for dilution of all sorts of drainage waters has been proven wrong and must be rejected. Rather, the planning effort in relation to persistent slow-decaying pollutants must become preventive-oriented as large-scale problems, once permitted to develop, become almost impractical to correct. Therefore, future investigations will be geared to defining long-term quality trends and specific plans for pollution control.

In accordance, therefore, with a re-statement of its policy for Water Use in Ontario, the O.W.R.C. intends to establish limits for each source of wastewater in keeping with the long-term water needs within the tributary drainage basins. This is a policy which will take account of the many beneficial uses of water including: public and industrial water supplies, recreation and aesthetics, fish, aquatic life and wildlife and agriculture. The needs for each of these uses will be established and protected by ensuring that reasonable use is made of natural waters for wastewater disposal.

The task in the immediate future will be to develop comprehensive pollution control programs. Increased emphasis will be placed on improved surveillance and forecasting the effects of pollutants on the rivers in Ontario and the Great Lakes and defining the magnitude and benefits of required pollution control programs.

When established limits have been set for each source of wastewater in keeping with the long-term water needs within the tributary drainage basin, action will be required to establish the necessary treatment works. Research and development will be required to provide treatment processes capable of meeting the established standards. This will include the need for removing nutrients, toxic trace organic contaminants and disease-causing bacteria, parasites and viruses. There still will remain the need for improving normal treatment processes which are designed for the removal of oxygen-consuming contaminants and suspended solids.

With the problems of forecasting treatment requirements and providing treatment processes capable of removing the contaminants both being solved, there will still remain the need for continual revision of methods of financing and developing individual and joint wastewater treatment facilities that are within the financial capabilities of the taxpayer. The new Provincial method of financing is now in its infancy and further experience is required before the overall effectiveness of the new program may be determined. With the inclusion of the sewage collection facilities in the Provincial financing program for small municipalities, it is expected that the great number of remaining municipal sewage problems can be eliminated.

Summary and Conclusions

From the foregoing, it will be apparent what problems of pollution control are being given increasing attention in the Province of Ontario. As the Province further develops and its wastewaters increase in volume and complexity, more scientific programs will be required to forecast wastewater treatment requirements to maintain our basic objective of using our water resources wisely. With a forecast of requirements, a parallel research program is required to develop wastewater treatment processes which are capable of removing nutrient, organic, pathogenic, and toxic materials from wastewaters.

If our water resources are to be protected, it is obvious that sources of pollution must be controlled. Negligent municipalities will be required to undertake adequate treatment of their wastes. With the additional methods of financing which are now available to municipalities for the construction of treatment facilities, compromises in the degree of treatment can no longer be permitted. Pollution control requires large expenditures but it is cheaper in the long run to prevent pollution than to attempt to remedy it when it has taken place.

While I have indicated the need for the development of new and improved methods of treatment, meaningful water quality criteria, and improved methods of forecasting treatment requirements, nothing would be accomplished if no action were taken until all the answers were obtained. Therefore, the Province is proceeding with a comprehensive inter-related pollution control program using the tools now available. This is to ensure that our water resources are utilized wisely. At the same time, an active research program and the continual improvement of the survey and forecasting functions are being pursued to meet the needs of the future.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"ENVIRONMENTAL MANAGEMENT IN AN

EFFLUENT SOCIETY"

HON. M. D. DYMOND, M.D., C.M., LL.D.,
MINISTER, ONTARIO DEPARTMENT OF HEALTH.

Introduction

Right at the outset, Mr. Chairman, I feel that I should ask the indulgence of our guests for the title I have chosen for this evening's speech -- Environmental Management in an Effluent Society. Being a Scotsman, it did not occur to me that anyone could be less than vitally interested in any topic associated with the reduction or elimination of waste -- a hateful word to any Scot! But, as I sat here this evening, enjoying an excellent dinner -- which, by the way, is not an unusual event in our affluent society -- I realize that Ecclesiastes had a point when he said -- "To every thing there is a season, and a time to every purpose under the sun." I concede that one would not ordinarily select the hour immediately after a large dinner as the most appropriate time to talk of effluents and the need for controlling their disposal. But while we dined, I had an opportunity to observe how well we all cleaned up our plates. Believe me, not all of this audience is Scotch! We are leaving a problem of waste disposal in the wake of this dinner! They need to be spoken to!

I want to extend to all of you a most cordial welcome on behalf of the Prime Minister and all my colleagues in Government to this gathering. Because of the importance which we as a government attach to this subject, all of you have been particularly selected for invitation to participate in the proceedings. I know all of you have with us much concern for the problem of controlling wastes. I realize many of you have attended similar or comparable conferences and I can tell you if facilities had been available a great many more would have been invited to attend this one.

THIS CONFERENCE IS THE FIRST to be convened by the Government of Ontario for the purpose of obtaining an over-all view of the problems confronting us in the management of our wastes -- wastes which, in the final analysis, have to be disposed of into our air, our water, or our soil; wastes which, in their disposal by one means or another, have already caused problems of pollution and which threaten greater pollution unless the means is found for their control.

SOLUTIONS TO THE PROBLEMS confronting us will neither be easy nor cheap. Indeed, in this Province particularly, with its expanding economy, its growing population and its increasingly higher standard of living, the problem of waste disposal is growing at such a rate that for the foreseeable future, we shall be running hard just to keep up. To get ahead, to improve the situation, will require even greater effort from each and every one of us.

DURING THIS MORNING'S PLENARY SESSION an attempt was made to outline in broad terms the major problem areas in the three fields of air, water and soil pollution. In the concurrent sessions this afternoon, the government's programs for control of these three classes of pollution were described with particular reference to your special field of interest, that is, agricultural, industrial or municipal. The sessions on Tuesday and Wednesday will explore in greater depth special problems with which we are confronted, and the possible means for their solution. I feel my own contribution to your discussions should include brief reference to the health implications associated with our waste disposal problem, and outline the Provincial Government's position with respect to the control of pollution.

Water Management

It will be of interest to this group particularly to know that Hippocrates, the Father of Medicine, writing some 300 years B. C., recognized the influence of the environment on health. He wrote: "whosoever wishes to investigate medicine properly should consider the seasons of the year, the winds and the waters in relation to health and disease". During the intervening centuries, man has made tremendous strides in elucidating the causes of disease. The "miasma" theory -- the transmission of diseases such as cholera and malaria by unhealthy air -- was largely discarded following the discovery of bacteria, and the subsequent identification of the causal organism of a host of infectious diseases. I do not think it is necessary for me to remind this audience of the progress that has been made during the past century in the science of microbiology and in the development and application of epidemiology. The astounding reduction in water-borne diseases is largely the result of their application to sanitary science. Today we have many alternatives to choose from in treating water for bacterial contamination: softening, taste and odor control, and perhaps most recently, artificial fluoridation, but the most important treatment is, and will continue to be, the treatment of water to prevent the transmission of disease. There are still important areas to be explored in this field. In addition to the problem of ensuring a safe supply of drinking water, has in recent years been added that of preventing pollution of our streams and rivers and lakes.

ALTHOUGH ONTARIO IS VERY fortunate in the supply of water within its boundaries, it has not been able to avoid many of the problems associated with water use. To solve the present problems and to counteract the occurrence of future ones, proper water management must be considered of paramount importance if we are to ensure equitable and maximum use for all purposes. The uses of water are manifold -- the more important being domestic, municipal and industrial water supplies, power and navigation, recreation and fishing, agriculture and the dilution of waste effluents. In a proper water management program, each use of water is recognized and the maximum use of water for such purposes maintained.

IN THE EARLY 1950's, due to the fact that more water was needed in some areas and available supplies were becoming polluted, the Government of Ontario realized that some new financial arrangement and stimulus of water supply and sewage disposal work was needed. The end result was the passing of the Ontario Water Resources Commission Act in 1957, and the formation of the Ontario Water Resources Commission. This placed the responsibility for all phases of water management in Ontario, including pollution control, under a single agency.

THE INSPECTION AND supervision of municipal sewage treatment were the responsibility of this newly-formed Commission and it was also given the authority to enter into agreement with municipalities for the financing, design, construction and operation of sewage treatment projects.

This meant, of course, that municipalities could now avail themselves of more favorable financing and expert supervision of construction and operation of both water and sewage projects.

Although this arrangement did provide a good deal of stimulus to this construction of needed facilities, many of the municipalities could not assume this added debt. For this reason, the authority of the O. W. R. C. was extended in

1964 to allow the construction of wholly provincial-owned water projects and to wholesale water to municipalities at cost. In August of 1965, this provincial ownership concept was extended to include sewage works as well -- both on an area and an individual municipality basis -- whereby sewage might be accepted and treated, again with the rate being based on usage. One of the important advantages associated with this type of project is that it overcomes the problem of compromises being made by municipalities either with respect to the degree of treatment or the type of construction undertaken.

A municipality now has three choices by which it may undertake to construct necessary works -- on its own; as a standard O.W.R.C. project based on O.W.R.C.-municipal agreement; as new provincial projects. Some of you have probably heard earlier today, that, to date, some 393 projects serving 207 municipalities have been developed or are under development on the basis of an O.W.R.C.-municipal agreement, at a cost of $153 million. Of this total, 225 projects were for sewage treatment facilities at an estimated cost of $118-1/2 million. The programs of the Commission have largely been responsible for twice as many sewage treatment plants being constructed in the past ten years than in the previous thirty years. Of the 997 municipalities in Ontario with sanitary sewers, less than 2.5% are discharging raw sewage without treatment, and this percentage is diminishing rapidly. The majority of these have tabled active programs for sewage works before the Commission and negotiations are continuing with the remainder to provide waste treatment. Where such works are needed, sewer extensions will not be approved and similarly, where pollution problems exist within a municipality because of the lack of adequate treatment facilities, recommendations are made to the Department of Municipal Affairs against further subdivision development until a satisfactory program has been worked out.

No account of the pollution control problem would be complete without a reference to industrial pollution. Because of the progress which has been made in the control of pollution from municipal sources, attention can now be focused upon pollution caused by industry. In the treatment of industrial wastes, problems of a somewhat different nature exist because of the volume and complexity of the effluents which must be treated. A tougher attitude is being adopted toward offending industries with the realization that this problem must be remedied as well. A firm step forward was taken by the Commission in industrial waste control by the sending of a directive to the pulp and paper industry in December, 1964, this in turn being followed by a directive to other industries in the spring of 1965. This directive set out the effluent objectives desired and the timetable in which these objectives should be achieved.

Where the Commission is not satisfied with the progress which is being made or the co-operation which is being received, injunctions and prosecutions follow. The terms of the O.W.R.C. Act apply with the same force to industries as they do to municipalities, and in some instances, in fulfilling its responsibility for the protection of the Province's water resources, the Commission has no other alternative than to have recourse to the courts. In all fairness, it should be added, however, that industry on the whole has been co-operating in a commendable manner. Since the O.W.R.C. was formed, industries in Ontario have spent over $120 million on waste treatment. This is exclusive of those that are connected to municipal systems, where in some instances, surcharges are paid to the municipality for the treatment of their industrial wastes. This has resulted in a marked improvement in the quality of the Province's water sources.

In any discussion on pollution control and its effects, the Great Lakes must be mentioned. As far as this country is concerned, the Great Lakes Basin contains the largest concentration of people anywhere in Canada, and the predictions of population growth indicate that this concentration is going to increase greatly. Hence, the Government attaches great importance to the quality of the water in these Great Lakes.

As a result of a reference from the Governments of Canada and the United States to the International Joint Commission in 1965, the Government of Ontario through the Ontario Water Resources Commission, is participating in a program of pollution investigation in the Great Lakes in co-operation with departments of the Federal Government. This initial program of Great Lakes studies, ending in 1968, will terminate with a comprehensive report to the International Joint Commission. It is anticipated that after 1968, the survey will become a continuing surveillance effort designed to provide for more intensive pollution control measures and parallel improvements in the water quality of the Great Lakes.

Since the start of this program, vessels operated by the O.W.R.C. have covered monitoring stations on the Lower Great Lakes and the connecting waterways from the St. Mary's River to the St. Lawrence River.

For many years, the O.W.R.C. has been developing a water quality monitoring system for the inland lakes and rivers of the Province of Ontario. Thus, levels of pollution in these waters are being determined and compared with the water quality objectives. From the results of this program, it is possible to determine the sources of pollution and the degree to which corrective action is successful.

With the predicted future population in this Province and the increased use and re-use of its waters which will take place, we must raise our standards for degree of treatment and qualities of both municipal and industrial effluent. In connection with this, the Commission announced last June a change in "policy guidelines" with respect to water quality objectives. Through extensive surveys of individual watercourses, the assimilation or self-purification capacity of those watercourses is determined which indicates the amount of wastewater treatment necessary before it is discharged to the receiving stream. In other words, this is a more realistic approach to waste treatment, keyed into the use that is being made of the receiving waters. It means, further, that treatment units can now be specifically designed to meet the needs of these waters. In some areas, of course, such as that of the Great Lakes, this may well mean higher degrees of treatment than have been required in the past.

Of concern to us is not only the volumes of improperly or untreated wastes being discharged to these waters -- although an active program is now under way to diminish the volume of these wastes -- but, also, the fact that tremendous volumes of nutrients are discharged in these wastes, resulting in the over-fertilization of these waters. Continuous research is being carried out on treatment methods with the view to removing these nutrients more effectively. Methods in use in other countries are being evaluated and advice sought from those in charge of research programs in order to keep abreast of the latest developments in all these fields.

There is also the question of pesticides and herbicides about which relatively little is known insofar as their effects in water and the build-up in the flesh of fish. We do know something, however, about the build-up of DDT in the flesh of fish -- especially in Lake Erie -- and some of the side effects that this is believed to have had. There is no indication of this having had any effect on humans, however. Nevertheless, it is mentioned only to point up the concern which is felt over the increased use of many new chemicals today before their long term effects are known. The use of pesticides is increasing year by year and studies have been conducted to determine the most effective and non-hazardous rates of application of these chemicals to water. The laboratory and research work of the various departments concerned with these pesticides is being co-ordinated. A permit system is in operation whereby the O.W.R.C. in co-operation with the Department of Lands and Forests, controls the application of these chemicals to water so that all the ramifications of this addition are allowed for.

Over the past few years, a pollution control program has been developed in Ontario which is sound, is gaining momentum, and is designed to clean up what pollution still exists.

Waste Management

Linked in some of its aspects to the conservation of our water is the need for control of our own solid wastes. If all sources of solid wastes -- domestic, industrial and agricultural -- are considered, it has been estimated that the rate of production is 8 lbs. per person per day, or 1-1/2 tons per person per year, giving a total annual production for the province of about 9,000,000 tons. This volume is increasing by about 4 per cent per year (2% for capita increase, 2% for population increase) so that by 1985 we shall be faced with the problem of disposing of double this amount of refuse.

The health implications which arise from lack of proper refuse disposal practices need no elaboration here. You are all aware that uncontrolled garbage dumps serve as a breeding place for flies, rats and other pests which provide potential reservoirs for a number of diseases.

The means of control for all of these pests lies in denying them access to putrescible material. This may be done by means of aerobic composting, incineration, or sanitary landfill. Daily compaction of refuse in a sanitary landfill operation including six inches of compacted soil will prevent both emergence of flies which may be hatched in the refuse and penetration by rodents, thus resulting in an operation which is free from health hazard.

Protection against pollution of water is more difficult to ensure due to the greater number of variables. The most obvious factors involve the chemical and physical characteristics of the local soil and the distance to surface and ground water. There is evidence to indicate that a high degree of bacterial purification will occur for any material leaching through about ten feet of active soil. The stabilization of inorganic salts is much more variable and some may travel considerable distances and, in fact, may only be dissipated through dilution.

In recent years, the trend toward increasingly larger operations for livestock and poultry production have posed a new problem in the large volumes

of fecal wastes they produce. Practical and economic means for handling this sewage are still in the developmental stage.

Recognizing the growing need for the regulation of refuse disposal, the Public Health Act was amended during the last sitting of the Legislature by the introduction of Section 95 a. This section provides authority to prohibit the establishment, alteration or enlargement of waste disposal systems or sites unless a certificate of approval has been issued by the Department, and to prohibit the deposit of waste on any land or in any building which is not approved as a waste disposal system or site. Householders disposing of waste on their own land are exempt from the provisions of the Bill unless such disposal creates a nuisance or a hazard to health.

Provision is made to permit waste disposal systems and sites which are in operation when the amendment comes into force to continue in operation under a certificate of approval or, where the standards set out in the regulations are not being complied with, under a provisional certificate of approval.

New waste disposal systems or sites may not be established or existing systems or sites altered or enlarged until notice of intent has been published in the local newspapers and the Department has issued a certificate of approval.

Applicants, other than municipalities, are to furnish a financial deposit to ensure that waste disposal systems or sites are satisfactorily maintained both during active operation and afterwards. Authority is given to order the removal of waste from any site that has not been approved, and to order the necessary action to be taken to bring a waste disposal system or site to a standard which conforms with the regulations.

A municipality may be required to initiate waste collection, or to establish or improve a waste disposal system, and it is not necessary for the council, in such circumstances, to obtain the assent of the electors.

The subsequent use of land which has been used for waste disposal will be subject to Departmental approval for a period of 25 years.

A waste management section has been established in the Environmental Health Branch of my Department to administer this Section 95 (a) of the Public Health Act. Regulations are now being drafted preparatory to the proclamation of this section of the Act. In the meantime, information is being assembled on existing installations and the necessary preliminary administrative arrangements are under way.

Air Pollution Control

I shall not attempt, in the limited time available this evening, to review in comprehensive fashion what is known to the present concerning the effects of air pollution on health. Much research has been done on the subject since 1948, when 20 people died and 6,000 became ill at Donora, Pennsylvania, and since the smog of December, 1952 in London, England, when nearly 4,000 more deaths occurred than would have been expected under normal atmospheric conditions. Let me summarize what is known in the following statements:

1. Acute episodes of high pollution have, on occasions, been associated with increased rates of illness and increases in mortality, especially from cardio-respiratory disease, during the episoded and in the days immediately following.

2. The majority of persons affected in these episodes were the elderly and those with pre-existing disease, particularly cardio-respiratory conditions.

3. The precise composition of the atmospheres during these acute episodes is unknown, since the investigations were made after the events.

4. In other studies, increases in mortality and morbidity have been shown to be closely correlated with increased levels of suspended particulates, and to a lesser extent, with sulphur dioxide.

5. The levels of individual contaminants found even during periods of severe pollution are well below those regarded as toxic for healthy humans.

6. It is not known whether long-term exposure to atmospheric pollution <u>causes</u> chronic respiratory disease.

Much of the information summarized above is derived from studies of human populations exposed to pollutants in urban atmospheres. It should be pointed out that the findings in these studies were related either to relatively brief exposures to high levels of pollution or to more prolonged periods of exposure in cities having rather persistently high levels of pollution.

It is the objective of the Provincial Air Pollution Control Service, by setting emission standards and establishing a program for their enforcement, to ensure that pollution levels shall remain below those which are believed, as the result of acute episoded or through prolonged exposure, to be injurious to health. It must be remembered that individuals vary in their response to most substances to which they are exposed. In any population there are susceptible or hyper-sensitive persons, some of whom will be affected by particular pollutants even in minute quantities. Just as in the case of sufferers from hay fever, for such individuals complete avoidance may be the only effective means of prevention of discomfort or even respiratory difficulty, and for some of these persons living in any urban atmosphere may present problems.

What further application has a knowledge of the health effects of air pollution to measures for its control? As our knowledge increases, it should be possible to establish realistic limits, or Air Quality Criteria, for the levels of the various pollutants which will be permitted in the ambient air. For example, restrictions on high sulphur fuels may be required, on a permanent basis, or during periods of inversion.

Secondly, knowledge respecting levels of air pollution and their potential for affecting health will undoubtedly assume increasing importance in future in such matters as city planning, the location of power plants, municipal incinerators and industrial operations, the development of nuclear power generating stations, and the continued use of internal combustion engines, including automobiles.

Thirdly, the application of future standards of air pollution may well be on a regional basis, the establishment of regional standards deriving from our knowledge of local population density, topography, meteorology, the concentration of sources of pollution in the area, and our knowledge of the potential hazard to health which emissions to the atmosphere could create.

I would like to return for a moment to the matter of Air Quality Criteria. Last Spring the U. S. Public Health Service published a document entitled "Air Quality Criteria for Sulphur Oxides" in which it was suggested, from a review of the literature, that exposure to a concentration of sulphur dioxide above 0.015 parts per million parts of air, if continued for a year or more, would result in increased morbidity from certain respiratory diseases. The figure of 0.015 p.p.m., has subsequently been widely quoted as the "safe limit" for sulphur dioxide. A critical appraisal of the references on which the document is based indicates that this conclusion is unjustified. For example, one of the references used as evidence that levels of 0.015 p.p.m. of sulphur dioxide caused an increase in hospital admissions concerned a study done in Los Angeles in 1961. In this study levels of other pollutants were also found to correlate well with hospital admissions. Los Angeles has a unique air pollution problem, in that the major pollutant capable of causing lung irritation is not sulphur dioxide but ozone and other oxidants. Not only is ozone more irritant than sulphur dioxide (the industrial exposure limit recommended is 0.1 p.p.m. for ozone and 5 p.p.m. for sulphur dioxide), but ozone is present in Los Angeles air at approximately 30 times the concentration of sulphur dioxide. Under the circumstances, the evidence that 0.015 p.p.m. of sulphur dioxide is harmful is far from acceptable. In fact, the "Air Quality Criteria for Sulphur Oxides" document itself warns

> " ... these effects do not necessarily, or in fact actually, derive solely from the presence of sulphur oxides in the atmosphere ... the effects of one atmosphere polluted with oxides of sulphur may be quite different from that of another atmosphere polluted with oxides of sulphur."

I expect that Dr. Lawther of the Air Pollution Research Unit, Medical Research Council of Great Britain may have more to say on this subject on Wednesday.

This is not to say that air quality criteria should not be developed. I only introduce a word of caution, that such criteria should be based on properly evaluated research. There are many variables whose effect must be considered, for example, the concentrations of the different pollutants present, their effect in combination as compared to their individual effects, the duration of exposure, the frequency with which adverse atmospheric conditions occur, the prevalence in the community of pre-existing cardio-respiratory disease, and the effects of other forms of pollution of the air we breathe, namely cigarette smoking and occupational exposure. In addition, in the development of air quality criteria sufficient flexibility should be incorporated that they may be made applicable on a local or a regional basis. For these reasons it is not possible at the present time to establish air quality criteria which are meaningful.

All of you who attended today's sessions will have realized that, with the passage during the last sitting of the Legislature of the Air Pollution Control Act and Section 95 (a) of the Public Health Act, the Province now has the legislative authority to control pollution of our air, water and soil. The means for implementing this control exists in specific agencies or departments of the government. The Ontario Water Resources Commission has, in its first ten years, already

achieved results of which we may be proud. This is not to say that water pollution is licked. As I indicated earlier, in our expanding society we must run hard just to keep up.

But I have pointed out the major shifting of emphasis in the O.W.R.C. program to that of water management. The same concept, that of conservation and management, must apply to our resources of air and soil.

My Department has responsibility for developing and is developing, Air Pollution Control and Waste Disposal programs with all possible speed. But the wise management of our air, water and soil resources entails more than just the responsibilities of the Department of Health or the Water Resources Commission. Many areas of society, and many departments of government, are affected by, or are concerned with the use made of our environment. For this reason an Advisory Committee on Pollution Control was established by the Honourable the Prime Minister a little over a year ago. This Committee, composed of the Deputy Ministers of Agriculture and Food, Energy and Resources Management, Health, Lands & Forests and the General Manager of the Ontario Water Resources Commission, is responsible for co-ordinating the various activities of the Government and for ensuring the development of a comprehensive, unified program in the task of managing our environment. The Committee has, since its formation, been most active in instituting an orderly approach in a very complex field. It is proving a valuable weapon in the Government's attack on a problem that concerns us all -- Pollution. May I assure this audience that it is the Government's intention to augment the attack on all fronts, and with the utmost vigor, so that this Province's bountiful resources shall be restored and shall continue for the enjoyment of those who follow us.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"POLLUTION AS IT AFFECTS RECREATION"

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The original meaning of pollution is to destroy the purity or the sanctity of some valued thing, or to make filthy or foul such things as air, water, soil, or scenery. The original meaning of recreation is either that of recreating one's self, or that of pleasurable exercise or employment. In the non-technical sense, it is very easy to see how pollution affects recreation. One of the real difficulties is to indicate such results with precision. This is difficult because pollution, and our present attitudes which consider pollution a minor misdemeanor rather than a crime against humanity, combine to change our attitudes to and our practice of recreation. In many senses, the prevalence of various forms of pollution has changed our lives and our habits, and we are scarcely conscious of the change. The first and prime effect of pollution is to so change our total environment as to make our patterns of recreation a reaction against a hostile environment, rather than a response to a favorable one; so in many ways the forms of our recreation are caused by the results of pollution. So it is, to give a practical illustration, that the wealthy first forsook the cities to begin the eutrophication of lakes; so it has been that, when the middle class pursues the same pleasure, the more affluent proceed to pollute the West Indies, or flee to enjoy the charm of Lisbon or Lima. Whoever heard of the jet set taking in the charms of Wabana, or Sudbury, or Hamilton, or even Toronto? Who now spends a summer on the beaches alongside Lake Ontario where the signs say "no swimming" or "do not drink this water" if he can help it. How many times have we taken our children out for a walk in the countryside, only to say "watch out for pesticide residues, beware of septic tank effluents, and don't touch that dead fish!"?

Pollution Limits Our Recreational Potential

The mega-problem which we lump together in the title "pollution" severely limits our recreational potential. It does more: it speeds up the pressures and increases them. It forces more and more people to go far afield for some area which is referred to as "unspoiled" -- a term which in itself indicates the nature of our thinking in relation to environmental management. In short, because our cities and their immediate environs are seriously affected by pollution of various kinds, more and more of us want to move, to areas where we can go on pretending that we still live in a rural society, and to areas where we can build a summer home, fill it with modern gadgets and facilities, bring in a boat, bring in packaged foods, and yet expect a totally unsuitable or unabsorbent material such as granite to absorb our septic tank effluent, and dump our garbage in some suitably remote place, or burn it and pollute the air. In such areas, as we add to noise pollution, air pollution, and water pollution by zooming around in our powerboat, we can ruminate on the undoubted fact that we are creating an awful mess, and we can console ourselves, and so often excuse our inaction and indifference, by pretending that the problems we are creating are so complex, and so beyond our control, that nothing can or should be done until we have all the answers. In this way, rather than preventing the building of septic tanks in totally impervious areas, we prefer to let it happen, and blame science for not making granite a suitable material for such activity. In this way, rather than provide a decent environment in our cities, we hope to handle the vast influx of people into northern areas, and then are surprised that the demand constantly accelerates and increases, thus creating a problem of recreating ourselves, known as the recreation problem.

The mega problem of pollution, as it affects recreation, is already complicated enough without worsening it by actions which can only be called

short-sighted, if we want to be charitable, and stupid if we want to be blunt. It is stupid, to let septic tanks be built on totally unsuitable soils, or cottages to be built on very small lots, when any competent engineer can forecast what will happen. It is evident that if we cannot bring ourselves to prevent the wholly obvious, then the more complex problems which need research and action will only be compounded, and will worsen. We could, in fact, begin to ameliorate the most evident effects of pollution affecting that kind of recreation, by having sensible building and zoning regulations and by enforcing them. In just the same way, we could insist on suppressors for automobiles, and begin to ease the decay of city environments. This would begin to take some of the pressures off the recreational areas.

The Broader Concepts of Recreation

Much of the vast pressure of recreational demand is due to the unsatisfactory environmental management in our urban areas. This is also compounded by our curious view of recreation as being a matter of outdoor activity, generally camping or cottaging, removed from urban areas. It is further complicated by the prevalent attitude that we all have a licence to pollute as much as we like; and by a further attitude which seems to say that these things are ultimately uncontrollable and incapable of direction; to this, add the view that really we are still rural and with unlimited space and resources, the secret hope that the cities will go away, and the curious idea that governments exist to pass mega-problems rapidly from hand-to-hand, preferably letting them fall back on the individual; and we see some reasons for the curious batch of problems which confront us.

Consider the way a Frenchman or an Italian or a Swede can sit on the sidewalk and enjoy at his table, a very satisfying form of recreation involving vast variety; and contrast that with the Torontonian who says, no, we do not do that. It's unpleasant to sit there in the fumes and the noise and the air pollution, in the dust and the dirt. Why does he not conclude that we should clean up the environment, instead of his present conclusion that we should not even try to achieve this kind of activity?

A very simple, and probably most healthful form of recreation, is going for a walk. Partly, our problem is one of where to walk, which is not entirely unconnected with our poor planning; but the prevalence of fumes from cars, air pollution in our cities, and such items as garbage, pesticides, and filthy water in ditches, streams and lakes, makes many existing living-areas scarcely suitable for walking, and that in its turn limits the demand for places in which to walk, and limits the scope of our recreation, for all ages. Yet the creation of the Bruce Trail, 420 miles from Queenston to Tobermory, shows that we can and do want to walk; why not do this in all areas, not just one? Obviously, better environmental management and control of pollution would assist this desire. We do not usually recognise the inhibition in which pollution plays so great a part. We prefer to blame the car.

It would be a fascinating piece of research to pursue the effects of the various forms of pollution upon so simple a recreation as walking, and the results in indifference to architecture, civic design, the care of urban trees, the feeling that parkland is not needed in built-up areas because we might have the garden or the cottage of limited use. Suffice it to say that this unsuspected side

effect of pollution and poor planning needs more study.

Have not water pollution, soil pollution and air pollution played a key role in the decline of cross-country skiing, enjoyment of the beaches and shores of the rivers, streams and lakes of the southern part of Ontario? To what degree, we scarcely know; but we can see that scarcely a stream in the urbanized and industrialized areas has escaped; we can see though we do not fully know, the effects of the misuse of pesticides upon the small creatures and the weeds and the non-weeds, and the birds of Ontario. We see the physical blighting of the former recreational areas on Lake Ontario, or along Lake Erie; we see the consequence in the over-use of lakes which were the playgrounds of fifty years ago; we see the decline in fishing, in ice-boating, in beach-combing. We can not perhaps put numbers to match the concern, we can not yet produce precise statements of the many side effects, but we can see the difference between the state of events of twenty years ago, and the present problems, and we suspect a worsening, and we know we will pay for these errors by changes in our manner of life. In effect, the pleasures of the countryside have been curtailed and reduced, if not wiped out, for too many people by a combination of changes in which the collection of symptoms we call pollution plays a significant part. A philosopher might warn us that the townsman's links with the land are tenuous enough at best; and that this kind of severance can have serious consequences in helping make more difficult the appreciation of the problems of the countryside, in an age when the urban man will be the effective custodian, either by his concern or indifference, by his choices and by his priorities, of the well-being of the land. It is time we included the neglected disciplines of sociology and philosophy to help us understand all these complex consequences. It is also time we used the comprehensive ecological view, in seeking to understand what we have done, or left undone.

Pollution is when Things are Unpleasing

Sometimes, to judge from the technical literature, we might think that these problems are unconnected, but what hits the citizen is the totality of the results. He is not bombarded one day by the lead poisoning from automobiles, another day by the sulphur dioxide from a plant; and on yet another day by the fly-ash from burning something. He is confronted every day by a complex pattern of symptoms of misuse, mismanagement, and waste of resources which we segregate and call respectively air pollution or water pollution or soil pollution. His recreational life is affected adversely when his favorite urban area smells horrible or feels unpleasant. He is limited in his recreational responses when his daily walk or his weekly exercise is limited by foam in the stream, garbage in the trees, or when every beach within forty miles is unusable; or when the plants in his garden are covered with dust from the sky. In brief, for the average man, pollution is when things are unpleasant. He has usually, and perhaps without thinking, adjusted his life to meet the unpleasantness; but he is the poorer thereby because his life is more confined. His ranges of choice and thus his real freedom are restricted.

Urban Recreation

Consider the general levels of unclean air in our major urban areas. Who can say what patterns of recreation have been cut off by this? Plot on maps the incidence of well-used recreational facilities and the incidence of forms of

pollution. They almost exclude each other unless we move to indoor forms, and probably air-conditioned at that. If our citizens were all as free to choose as the richer ones, would not most move out to relatively cleaner areas? This general level of uncleanliness as an inhibition on recreation has yet to be studied in totality, but surely there must be some effect and probably quite profound.

More localized problems of recreation give point to this. Consider the relative decline in the pleasure-gardens; mostly blamed on the era of prohibition, but also in some measure a consequence of the dumping of the filth of our society into the air, the water and the soil. Denmark has its Tivoli in Copenhagen. Most cities in Europe and in Latin America and many in Asia and Africa have pleasant open squares. We tend to have rather sad looking and quite blighted areas.

The Range of Recreational Response

It is a difficult problem to set out with scientific precision the complex side effects and the direct effects of this sort of poor level of environmental care in our urban areas. It is also quite difficult to estimate the regional effects in the countryside around. The few studies done are carefully couched, and quite properly so, in very precise language. They are virtually unintelligible to the public. Anyone who spells out with precision and real meaning the air pollution in a steel town or a metropolitan area with oil refineries or power stations, or the dangers of septic tank suburbia or overloaded sewage plants, in terms which hit people where they live, is liable to be regarded as an enemy of society. Presumably if we go further, and suggest that everyone pollutes by condoning the pressures which make it difficult for doctors to protect us, or by condoning the lack of co-ordination which encourages our various levels of government to drag their feet; or if we go that extra step and say that we have to change some attitudes to our surroundings, the last doubts will be removed.

But in this area it is time we stopped looking for scapegoats. The broader meaning of recreation seems to indicate that pollution is at the opposite end of the scale from the process of recreation. It is destructive where the other is creative. It endangers life where recreation strengthens it and enlarges it. In summary, pollution is affecting recreation by extending the unaesthetic and by being evidence of individual or collective behaviour which is against human values. To say these are intangibles is only partly true. We know the difference in enjoyment between an area which has its pollution problem under control and one in which pollution in its various forms runs rampant. At one recent meeting where the problem of setting standards was discussed, a doctor stated that the best test for water pollution was to drink some and, if you were ill, it was substandard. Similar thoughts run through the minds of citizens unversed in technical complexities. When they say that an area is unpleasant for recreation, they sum up these standards. I agree with those who say "It's a nice place but you wouldn't want to stay there", and I do not wish to volunteer to drink the filthy water. The range of recreational response is severely limited by the range of freedom given to pollute.

The Consequences

The direct result of the restriction of this range of response is felt in the increase in two sets of reactions. Since the cities are not on the whole pleasant

places for recreation unless we are wealthy or specially favored and can insulate ourselves by the kind of places we choose, the flight from the city is speeded up. So, ultimately, is the flight from suburb to suburb, since suburban blight fast makes its appearance. All levels of society clamor for more roads to make the trek away from the great smoke. The first consequence is the acceleration of the move to buy up and protect for ourselves big enough chunks for the future. Thus the gentleman farmer leaves the city and pollution in the urban areas has helped to create a new and yet ancient sport, typified by the various hunt clubs. For those not so favored the ten acre, or even the one-acre rural estate, appeals. This tends to proliferate the problems of pollution and starts another sort of cycle. In this way, the response for the poorer man, the response which should send our society out right now to buy up all the major river valleys and all the scenic areas within fifty miles of our main cities, is severely inhibited. It is inhibited because land values are being increased by this strong searching for the "estate" however elusive, and because, being condemned each to save himself, we grudge spending the money that might build us an expressway to our paradise, on people who as yet are rather voiceless.

In this curious fashion a whole tract of land within and somewhat beyond the urban shadow is denied to the great mass of the people, and to some extent made the special preserve of select groups. This means that the larger demand can be met only in the urban areas or in the farther reaches of the Province. It would take a considerable feat of sociology to explore these consequences fully, but it is not unconnected with the increases in passive recreation. This is not to condemn or judge, but the limitations on the full range of urban and near-urban areas in their recreational possibilities must give more time for watching television, indoor sports, spectator sports, elbow-bending and similar diversions. Gin has always been the fastest way out of problem urban areas; few would agree it is the best. Yet the demand for space must needs be met and for many, it must be met in the north and the far north.

To the flood which is to come, is therefore added the extra demand of those who in various ways must needs strike out for some recreation in more favorable and pleasant environments. As an example, it has been estimated that the Kawarthas, now visited by about 250,000 people annually, may have to cope with 6 to 12 times that number by the time another twenty years has passed. On this scale, it has been suggested that recreation might be worth $300,000,000 per annum; but already the warning signals are out and the dangers of various forms of pollution particularly the process of lake eutrophication, make it clear that this could become a giant problem instead of a giant benefit. In the face of demands on this scale, the Government moved to set aside the last remaining large piece of Great Lakes shoreline: in North Georgian Bay. This is in itself evidence of the pressures to be faced. So far it is from present users. Similar pressures are now threatening the mature recreational environment of the Muskokas and Haliburton, and those who know the Huron shoreline have seen similar trends there. In all cases, there is every sign of the build-up of an impressive set of future pollution problems. It seems to suggest that our recreational enjoyment of these areas could be severely limited, that tighter controls are needed over land use, over location and development of cottage areas, probably using permanent sewerage facilities and treatment plants in areas where any concentration is expected. It calls forth the need for careful controls over boats and over garbage disposal. It calls forth the concern for better codes of behaviour on the part of those who use snowmobiles, or who go

ice-fishing, or hunting, or camping. Above all we clearly need in these areas proper management plans and clearer lines of management responsibilities. Is not one of the prime problems in this area of the effect of pollution upon recreation, that of the inadequacy of our present agencies of government at all levels in their lack of co-ordinated response; in their vulnerability to individual pressures?

A further consequence of the poor environmental management which has characterized our response to industrialization and urbanization is seen in the severe competition between individuals and public agencies in the search for recreational space. This is marked in areas such as the Kawarthas where research suggests we need about three times the present ownership of public parklands of various kinds to cope with the impending flood; and in the Muskokas where the tendency might be to push into small pockets, in mature environments, the people who cannot be accommodated on public lands elsewhere; or who are unable to join the rush for cottage lands which has now probably reached the Arctic or at the very least, James Bay. Thus, one of the long-term results of our attitudes to pollution, and our poor control, has been the creation of potential conflicts in our recreational areas. It is indeed most unfortunate that we have not yet carried out the large-scale studies of pollution and the large-scale study of patterns and needs in recreation for which such bodies as the Conservation Council of Ontario and the Federation of Ontario Naturalists and allied societies, as well as the various concerned experts, have been pressing. When these birds come home to roost a great many people at the federal, provincial and municipal levels in various parts of Canada, and in many parts of Ontario, will realize too late what whirlwind forces are unleashed when we ruin or damage ecosystems, and when the people affected start to feel the results. In many areas which depend heavily on recreation for regional development this can have serious consequences. It is our duty as concerned people and as experts to document as quickly and as accurately as possible the effects. In the field of recreation this is pioneer work. If these remarks have been necessarily general it is a reflection of the scarcity of research and the need for study. It is also a personal expression of the urgency and importance of this field. Even in the absence of the research we must strive to do what we can. There must be some holding actions or the problems may well become so complex and so extensive that though they are capable of being controlled we have neither the resources nor the chance to do so. And it is not inconceivable, so odd are the forces with which we play so blissfully, that some could be irreversible problems and that price would be severe.

Let us research and more accurately define the direct and indirect effects of pollution upon recreation as a prelude to the process of better management and more enlightened resource development which our "holding actions" may yet secure. I believe we will respond bravely to this challenge. It is a challenge which faces all technically advanced societies.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"FISH AND WILDLIFE VALUES IN POLLUTION"

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The person interested in fish and wildlife nowadays has two concerns that outweigh all others. One is the loss of habitat to industry, urbanization, and other forms of land use that destroy habitat, a loss sometimes necessary, but also sometimes unnecessary. The other is the degradation of what habitat is left by environment pollution. In both cases there is concern that fish and wildlife resources are given nothing like the consideration that their true value in the life of the Province would warrant. In the matter of environmental pollution, the general feeling among those who work with fish and wildlife is that, quite apart from the consideration they warrant because of intrinsic importance, they should be viewed as the equivalent of the coal miner's canary. Being especially sensitive, they give early warning of changes that affect all life, and the best way to assure a good environment for all is to keep it in good shape for fish and wildlife. If it is good for high quality species of fish and wildlife, then it is a high quality environment. Keep it that way and you are building for the year 3000.

The discharge of domestic and industrial waste products into the environment, and the use in the environment of products which change it in some way, have had a tremendous influence on fish and wildlife resources. Because the relationships of various animals in land and water to the environment, and to each other as part of it, are full of complexities and subtleties, it is impossible to set any hard and fast lines. It all depends.

Sometimes the effect of pollution in the environment may even be to produce some wildlife benefits. The smelters of the Sudbury basin have for years poured their waste gases into the air. As you well know, trees won't grow there. There was a day when nothing would grow, but lately the stacks have gone higher and now grass, sedges, weeds and some shrubs have taken hold. There are a number of small ponds whose grassy surroundings resemble the prairie sloughs of the West. You may recall that it is in the Prairies that the ducks like to nest, and there are very few on natural lakes in the woodlands of the pre-Cambrian shield. Interestingly enough, the ducks have found the sloughs of the Nickel Belt and seem to like them. I doubt that these ducks are numerous enough or important enough to be weighed in the balance against the potential of a productive timber stand, but they do constitute an interesting sidelight.

Some good chemists have even been heard to say that old automobile bodies sans glass and upholstery might help get rid of excess phosphates in our lakes. While it is possible that a case might develop for putting old iron into the lakes, I think we should have to draw the line at glass, and that for one reason only, because it is indestructible. The inner harbor of Tobermory has been used by yachts for one hundred years. Skin divers tell me that the bottom is paved to an almost unbelievable degree with bottles, old and new, of every kind and description. This may be why the fishing is disappointing. I wonder what some of our marshes will be like after a few decades of plastic shotgun shell cases. These shells may be a boon to the hunter, but if the long-term effect is detrimental to the game, he will have to take another look at them.

In almost every case where something is added to the environment we are concerned as much with the manner in which it is added and the place as with the thing itself. Some herbicide that will kill off aquatic vegetation where fish, ducks and muskrats would be eliminated by so doing, may one day provide the answer to wild fowl depredations on swathed grain in the West. As you know, ducks eat wheat. In the old days when grain was stooked nobody cared, because the amount eaten was a bagatelle. Now that grain is swathed and hardened on the ground it is

a different story. In the process of gleaning their feed the birds trample the lot, and may destroy a whole crop from which they eat little. Many of us have felt that the ultimate solution is chemical hardening of the standing crop -- either that or a biological solution by breeding a variety that will harden all at once as it stands.

Time and place may change everything. Warm water from the atomic power plant at Douglas Point into Lake Huron will probably make no difference to the fish. The same thing in chilly Lake Superior, if it ever comes, would probably do some good. At Nanticoke, on Lake Erie, we have our fingers crossed. The engineers came up with a calculation that sounds facetious, showing that the outflow would not be enough to affect the temperature of Lake Erie. What we want to know is the effect that the warm water is going to have on the game fish spawning areas that lie in its immediate path. Lake Erie may be moribund, but Long Point Bay has remained unchanged and supports more angling than any other area in the Province -- better angling too.

It is not always the side effects of environmental "control" that are undesirable. Sometimes it is the objectives of control itself. For example, a major offensive is being waged all over this Province against rooted aquatic vegetation. In its most destructive form it follows the course of filling in the marshy foreshore and building cottages on the fill. Then the weeds have to be cleared out of the area in front of the cottages. Typically also the whole bay has to be cleared of vegetation for water skiing. What everyone forgets is that all of this rooted vegetation is the habitat on which all the wildlife and most of the fish depend. After they become scarce, naturally the cottagers complain and want the lake stocked. The industry is inclined to question the necessity to get permission to use herbicides which do not kill any animal life in bio-assay, forgetting that there is more than one way to kill a cat. Remove a spawning ground and you remove a fishery. Remove its home and you remove the fish.

Agencies producing chemicals, and those using them in the environment, as well as other "polluters", if we can use the word, are sometimes incredulous of bad effects on wildlife, because they have run tests on experimental animals, and domestic animals show no bad reaction when the stage of agricultural or industrial use is reached. Susceptibility is more complex, and so is the natural environment. I can only cite the case of a friend who found himself in possession of two baby wildcats, or bobcats as they should be called, from a den. They were delightful and responsive little fellows, and the first thing he noticed, when he was able to handle them freely, was that they were covered with fleas. He took a modern commercial flea powder that he had been using on his own dogs and cats, and dusted one of the bobcats. Before he could get around to dusting the second he had a dead bobcat. I can tell you that he, and I, have had second thoughts since about using this powder on our domestic beasts, and inhaling it ourselves, but that is beside the point. This sort of thing is bound to happen when we transfer from an experimental or domestic animal to an environment containing a diversity of species. It is, to a degree, unavoidable. When it does happen let us admit that we are concerned, and that there is something at work about which we need to know a lot more, and which may change what we are doing.

Of course selective pest controls are coming. Another way to avoid that kind of trouble is to be reasonable about using chemicals, and thus cut the risk of something untoward. In one public place that I see daily, sprays are applied every year to shrubbery that is perfectly healthy. Why? I belong to the school that will rely on the vitamins in my beer until a deficiency is actually diagnosed;

then I might take pills. Trouble is worse if it is from something that need not have been done in the first place. In the same vein, it has become obvious that DDT has not saved anybody's elms. If we had started work years ago when the elm disease was first detected we could have had resistant elms available by now, and we might have had specific treatment. We first kill the song birds and then have to admit to the bird lovers that the only benefit was spreading out the period of elm removal.

Sometimes when pollution brings about a condition the cure offered is more pollution. One of the best examples of this happened when the tanker "Torrey Canyon" broke up off the coast of England. The sea was coated with a nauseous scum that killed almost every bird that touched it, and washed up on what had been a reasonably clean and attractive shore. People clamored for action, and so the whole vast area of land and water was dosed with a powerful detergent, one that is really lethal to aquatic life of all sorts. Thus the environment took a double beating, once from the disease and again from the cure.

We know, of course, that long before it was even established that the Cladophora plague of the Lower Lakes is caused by excessive phosphates in the water, it was proposed that chemicals should be applied to treat the algae. In the fish and wildlife business we run into this heavy-handed business all the time. In predator control in the West, for example, you poison the coyotes that ate the gophers because incidentally they kill a few sheep. Then you have to poison the gophers. It's a big deal if you are in the poison business. Investigation in the United States showed that in some cases the whole lot of sheep was not worth what was being spent to protect them. Surely, with pollution, the thing to do is to abate it, not to compound it.

The problem of glass and plastics in the environment is similar in kind to the much more serious one produced by persistent, non-specific poisons used in pest control today. They accumulate and what is much worse, and most important to wildlife and fish, they are concentrated in living organisms, and passed on from one to another in the food chain until a light concentration builds up into a lethal dose. Susceptibility varies. DDT, for instance, may never kill carp, but with trout and salmon it has been established that a concentration of 2.9 parts per million in the yolk sac is the threshold of trouble in the survival of the fry. At varying levels higher than that (but not much) the egg will hatch, but when the fry start to absorb the contents of the yolk sac they die. This information was obtained experimentally in New York State after failures in hatchery and natural spawnings. At about 5 parts per million nearly all died. This is an ether-extract measurement. It is a different reaction from that of the bobcat to the flea powder, less dramatic, but similar in principle and more insidious in the long run.

Naturally, with this information, we hastened to monitor our hatchery egg supplies, and we are afraid that it is only a matter of time until trout eggs from one of our sources can no longer be used. They are still below the critical level but the DDT is going up all the time. Incidentally, in the past we have had trouble having even this small amount of monitoring done. Reproduction of lake trout has collapsed in a couple of important Ontario lakes, and again we are having trouble getting eggs monitored, but we must be prepared to find similar conditions to New York lakes in some of ours, because our lake trout are very likely to be equally susceptible.

DDT spraying need not be heavy for such effects. An organized annual mosquito spray paid for by cottagers may be enough. We are reminded that the Atlantic salmon of New Brunswick have survived massive spraying over years for spruce budworm control. However, there is a very important difference. The yolk sacs of the salmon are laid down in the North Atlantic somewhere off Greenland, and so long as the fry and smolts are able, in natural feeding, to withstand what they encounter in New Brunswick until they get out to sea, they are safe. In our lakes small amounts of DDT are concentrated a little in plankton, a little more in plankton-feeding fish, and then still more in trout, and the gonads, especially yolk sacs, are perhaps the principal repository of the stuff in the trout. Every little bit counts.

Our only hope is that one day the trade will use non-persistent chemicals, and then in time the DDT will disappear from the environment. Our experience in building up populations where spawning has failed tells us plainly that hatchery stock is not an economic substitute. By the time we stock two-year-old lake trout and they have undergone the natural mortality involved in living to a catchable size, the Province has folding money invested in every fish you catch, and you don't have to buy a licence. If we were to withdraw the annual plantings, and tell the cottagers to buy their two-year-old fish, there would be the devil to pay. As I said, we have not yet sorted out causes, but I can tell you that where a good stock of fish fails to reproduce in an environment where they have reproduced in the past, something is at work, and it is not mergansers or otters.

The build-up of pesticides in the food chain is well illustrated by the lowly earthworm. You can spray DDT in amounts that hurt nothing except a few insects, and it falls on the ground. The earthworms, in feeding, pass the topsoil through their bodies and extract all the DDT which is deposited in them and does them no harm at all. They are not susceptible. In due time, however, any robin that eats two or three worms gets a massive lethal dose. Usually the food chain is more roundabout and the accumulation in the animal in the end is slower.

The failure of reproduction because of pesticides is something quite different from actual poisoning. We do not know how it works but it has manifested itself both in Europe and here in certain birds of prey. These birds have two characteristics in common: namely, long life and delayed maturity, which gives them a longer period for the stuff to accumulate in the gonads, and they are probably also highly susceptible. We have no idea how such delayed poisoning works in nature but we can guess. I recall a case where a wild mammal was found dead, with a clear diagnosis of metallic poisoning. Experimentally, a lethal dose of the same poison simply could not be built up in the same species; their bodies would reject it. Yet when they were subjected to stress this defence broke down and they died quickly. We suspect that many a healthy bird with a deposit of DDT in the fat has, when on a migration where the fat was used up, had the whole lot of DDT, which isn't used up, deposited somewhere in its gonads or its brain. Possibly the second or third time a bird gets a deposit in its brain, it dies, but the deposits in the gonads merely inhibit reproduction. You cannot duplicate these conditions experimentally. You may even be left guessing as to the food chain. One spring when people all around where I live were using heptachlor lawn spray for white grubs I had half a dozen dying scarlet tanagers brought to me. The scarlet tanager is what some call a "lovable" bird. Those were pre-Rachel Carson days but if this ever happened again and a connection

were suspected, the news would certainly cut into the sale of lawn sprays. Scarlet tanagers catch the eye in the color rotogravure section. You may well ask, why tanagers? The only answer is that they were there at the right time on migration, they were susceptible, and they were conspicuous on lawns and in shrubbery, in their death throes.

I say all this in the knowledge that the guidelines for pest control put out by our own Department of Agriculture and Food and others, including the Department of Lands and Forests and the Ontario Water Resources Commission, each year put less and less emphasis on persistent chemicals. This is better late than never, because the defenders of pesticides, along with others who put things into the environment, sometimes give themselves the image of men who, when all eyes were turned on them, continued to snatch at that fast buck, and to hell with whatever stands in their way. If they stopped for a moment to think of the nature of their products they must have realized that incidents supporting Rachel Carson would accumulate continually. This thing about pesticides and wildlife is real enough to make some of us poor wildlifers wonder if people really know what is going on in our own bodies. We live longer than eagles, and we know that we are continually accumulating pesticides in our own tissues. Our omnivorous habits are more reminiscent of vultures, which seem not to be susceptible, than of eagles, but what happens under conditions of stress?

Concentrations of humans and wildlife are generally in inverse ratio, except for the hardy scavengers, and air pollution is much more of a problem of human welfare than wildlife welfare. When it comes to water, however, humans merely have to drink the stuff. Fish have to live their whole lives in it, and all the organisms on which they feed must be able to thrive in it.

In the course of geological history any lake is a temporary thing -- certainly any freshwater lake. In areas of mature drainage there are few ways a lake can be formed. If you look south of the line of maximum glacial advance in North America you will see that there are very few lakes. There are ox-bow lakes, formed by the shifts of a great river flowing in a plain, a few small geologic sink-holes, one place where land subsided in an earthquake, and a large number of places where man has intervened and interfered with the drainage. None of these lakes, natural or artificial, are very old. There is plenty of geological evidence of past lakes. In Canada, by contrast, we have a vast number of lakes because glaciers displaced our former drainage system. No matter how many, or how few our lakes, no sooner does one come into existence than the process of its filling in commences. In the limnological sense, when it is very young it is not much use to fish, and when it is approaching death it is not much use either.

Rain falls as distilled water, the kind the ladies used to like to wash their hair in. In a normal water regime it goes into the soil, and the surplus appears as springs which form streams. The clearest spring has soil minerals in solution carried into the nearest lake, and any stream will have some materials in suspension. Given enough millions of years the stuff in suspension will fill the lake. The stuff in solution and suspension is the basis of life in the lake. It makes plants grow. Most of them are tiny plants in suspension in the water, and they are eaten by tiny animals which in turn are eaten by larger animals, and you have a progression from comparatively sterile water to a living animal community including fish. Depending largely on the richness of the soil through which

its drainage filters the lake may support abundant life or a small amount.

You will notice that I used the word progression. To progress means to step forward, and for anything that is alive, whether individual or community, all steps are in one direction, towards dissolution. In the words of the old hymn, each low descending sun finds us one day's march nearer home. We are reconciled to taking this view of ourselves as living individuals, but reluctant to see our society in the same light, yet it is a living unit, and must share the stages of life -- birth, growth, maturity, senescence and death. To a biologist, our society seems in a hurry to get the whole thing over with.

The aging process in a lake has been given the name eutrophication. A little bit of organic effluent can have an effect comparable to natural aging, but I protest that applying this name to the process of pouring effluents into a lake is a gross misuse of a good Greek word. "Trophe" means nourishment, and "tropheia" rearing. Most of our northern lakes are called oligotrophic, which is evidently intended to mean that they cannot rear very much -- certainly this is true. Rich lakes, full of nutrients and full of organisms, are called eutrophic, literally "good rearing". The way some scientists use Greek words is sometimes barbaric. Everyone recognizes that as nutrient material accumulates in an oligotrophic lake, the lake gradually becomes eutrophic -- moving from youth to productive maturity. If we pour nutrients in at an accelerated rate what happens is not good, which is what the "eu" part means. It is more like premature old age than healthy maturity. The increase of dissolved solids in one oligotrophic lake in northern Ontario as a result of the pouring in of an industrial effluent did not make it into a eutrophic lake. Instead, it became a sterile lake. Lake Erie already was a eutrophic lake. The accession of millions of tons of raw sewage day in and day out for more than a century has not made it more eutrophic. It has had an effect on the lake comparable to what we know would happen to a farmer's field if you were to dump on it all the manure from an enormous chicken factory. Up to a point it is fertilizer, or eutrophication if you like. Beyond that it represents for the environment what atherosclerosis does for a human individual. Lake Erie is at a point now where certain organisms that tolerate a shortage of oxygen are thriving, as are the couple of species of fish that thrive on these organisms. The small creatures that depended on a good supply of oxygen in the lower levels are gone or going, and so are the fish that used to depend on them. The blue pickerel that was the most important commercial fish in the 1930's is now listed in the official U.S. roster of extinct or vanishing species, and there is nothing you can do about it because the lake it used to live in does not exist any more.

Natural environments are constantly changing, but even when the substances added by pollution are similar to those added by nature, the change in the rate of change destroys the old living system and it is replaced by a new one.

Are these changes irreversible? I suppose that depends on us. You could aerate Lake Erie, at some cost, and proposals have been made. If the tide of pollution could be stemmed there would be some point in doing it. The straw that broke the camel's back seems to have been the proliferation of the alga Cladophora, as a result of the comparatively recent increases in the phosphate level. This in turn seems traceable to modern detergents. It is predictable that the phosphates in detergents will be removed in treatment plants. I am told it has been done experimentally, and what is needed is the will to do it. I have already mentioned the possible effect of old iron in taking a lot of phosphates out

of solution. One of the beauties of detergents is the way they knock out iron and iron stains. This is not to endorse the suggestion, made some time ago, that the depths of Lake Ontario should be used as a repository for solid wastes. Anything else than iron will have to be considered separately.

There are two attitudes that are, I believe, widely held, that could make us look as if we were the sorriest, most mercenary people on earth. One is that waters with cities must be given over to use as sewers. This proposal, when openly made for the Missouri River, provoked such indignation that it was disavowed. The Great Society to the south of us proposes to restore the Beautiful Ohio, and the British aim at restoring the salmon run to the Thames. The latter proposition does not look too impossible, because there are still trout down to the level of the Henley tow-path. We have a great inland water here, with beaches often as not closed to swimming. Twenty years ago there was a commercial fishery in the west end of Lake Ontario. To me the fact that there is a good fishery in the Binnen Alster inside the City of Hamburg is a good augury for the future of Germany, and the fact that there is nothing in the water surrounded by our Golden Horseshoe is a bad augury for the future of Ontario.

The second attitude is that we can freely turn any river flowing north into a sewer. It has been even proposed seriously that we should invite industries with troublesome wastes -- poisons of all kinds -- to build on these rivers and just let 'er rip! You can, I suppose, move the Indians out and put them on relief. All I can say is that when the flocks of waterfowl that frequent our northern estuaries dwindle away, and fail to show in their southern winter grounds, or worse still, when those that do show are adjudged too radioactive or too loaded with poisons to eat, I shall be glad that I am no longer in a position where I might be asked questions. Part of the image of this country is that no matter what it may be like up here, somewhere down in the north there is a great clean wilderness. When we paint that image over we shall cease to be what we are now in the eyes of the world and in our own eyes. I realize that progress inevitably cancels out wilderness. Wilderness belongs to young, lean societies. When they become old and fat you look for it in vain. We shall lose it soon enough without throwing it away.

The island of Great Britain is moist and verdant, and blessed with innumerable cool streams that once were all haunts of trout and salmon. Most of them still are, even though they now flow through an industrialized countryside. The total poundage of fine game fish taken would put any accessible part of Canada to shame. We are so used to the idea that the waters of any industrial area are a write-off, so far as quality angling is concerned, that one cannot help but be curious as to how all that fishing is maintained.

It is not because they do not have to watch out for pollution. There is an organization called the Anglers' Co-operative Association which has been in existence for nineteen years, which has taken over the watch dog functions formerly left to individuals. It is an interesting organization. It has a fluctuating and rather small list of members and subscribers, barely enough to keep an office open, but it is able to call on some powerful help, especially legal. It has investigated nearly 700 pollution cases since it started and very rarely does it fail to get abatement or damages, as the case requires. These anglers have behind them a simple fact. Every fishery in Britain, except for those in public reservoirs, belongs to some private owner. Many of them have changed hands at high prices and action is always entered on behalf of somebody who has suffered

real damage. It has been that way from ancient times. Over here the fishing belongs to everybody -- and thus to nobody. The A.C.A. exists merely to take action where individuals may not act themselves.

Two cases from some time back well explain why the Derwent, which flows through the industrial city of Derby, still has its trout. Action was entered against the City because its effluent was harmful to trout, and the City through its legal representatives, claimed in the highest court in the land that it was completely unreasonable to expect them to maintain the standards of a trout stream. The A.C.A., incidentally, acted on behalf of the "Pride of Derby Angling Club", which leased the fishery from the titled gentleman who owned it. The law lords said that the City had no more right to put its muck in the river than the citizens had to put theirs on the property of their neighbours. About the same time, and for the same City and River, an injunction was obtained against British Electric, a public corporation. All they had been doing was to run warm water directly into the River. Trout like it cool. The A.C.A. also deals with such -- to us -- trivia as mud running into a stream from a new road grade, or a ditch. It doesn't have to and the anglers are willing to go to court. This is actually a good example of a common form of pollution which we accept but which is quite unnecessary and not hard to avoid.

What it amounts to is that you can have good fishing, which means good water, in a river in a populated British countryside if you make it your business to have it. It is not only Britain. We get an anglers' magazine from Germany and there are lovely illustrations showing good fishing on the Ruhr River, of which you may have heard, and on the Binne, or inner, Alster, which I have already mentioned, in the industrial part of Hamburg. Quite a bit of fishing water it is; some of you may remember what it looked like in moonlight. Our private owners of trout streams, restricted to headwaters, often destroy what they own, and the only generally-held management concept is to dump in hatchery-raised fish.

I will be the first to admit that there are geological and climatic differences between Ontario and Western Europe which have influenced the impact of European settlement on our area, so that some of our streams have, inevitably, a less constant flow and a warmer temperature than they used to have. Within these limitations, however, we ask ourselves why we have to sacrifice water quality still further by deliberate pollution.

Some time ago the A.C.A. analyzed their comparatively few failures. In some cases the polluter could not be identified. In some other cases the polluter was insolvent, hence no damages. They call this failure. However, and this underlines the comparison between them and us, the most important single cause of failure was when the anglers who suffered from the pollution had no concrete evidence of interest, such as a valid lease, and had only tacit consent or a gentleman's agreement with the owner, who refused to become involved in the action. That sounds familiar. We, as individuals, fish the waters that we all own, collectively. As individuals we have sustained no damages at law. Collectively -- as owners -- well, forget it. In Britain, when a truck involved in an accident spills chemicals into a stream, the public liability insurance pays for the fish, for all the costs of clean-up and restocking, and for the loss of use and enjoyment during the period between kill and restoration because property damage has been done. Who looks after us?

Officially we have tried to do by statute what the British have done by the Common Law, but never, apparently, have we really meant what we said. Our first legislation, in 1865, had its teeth pulled in 1868. It is interesting that one simply cannot conceive of a judgment or an injunction obtained through legal action by the A. C. A. being set aside. Part of the explanation may be social. The A. C. A. has the Duke of Edinburgh for Patron. Apparently it is quite all right for him to be honorary keeper of a watch dog that has sunk its teeth into government corporations such as British Electric and the Coal Board, municipalities big and small, industries and private individuals, without fear or favor. I notice that His Grace, the Duke of Devonshire is President, and there are two more dukes among the vice-presidents (that is over ten per cent of the total number of non-royal dukes), as well as two additional peers, a couple of knights and one lone untitled chap, a Mr. I. M. Gluckstein, who has obviously been voted -- bully for him! -- into company that social climbers might envy. I venture to say that he owns some good fishing. Years ago Froude wrote a famous essay "On the Uses of a Landed Gentry". He included in his list the benefit of having statesmen whose recreation was in the clean outdoors, rather than the indoor sports, but did not mention clean waters specifically as a benefit. We can rectify the omission.

There is another thing that enters in, and that is the established monetary value of a sport fishery. Economists asked to evaluate wildlife and fisheries are inclined to writhe and mutter about the difficulty of evaluating services, and putting a price on intangibles, yet they recognize that our society does this all the time. For example, we pay prima donnas and comedians, who do nothing else than provide services. We pay some of them several times as much as others, because of an intangible but very real something about them. In order to buy the fishing rights on a British river you really have to shell out. The cost of catching a trout and what you can get for it from a fishmonger are two very different things, and it is the former and not the latter that enters into consideration when a fishery is evaluated.

We try the same thing here. The Department of Tourism and Information Economist, Mr. Peter Klopchic, made an evaluation of our fish and wildlife based on valid statistics as to how many people hunt and fish, and how much they spend. Using recognized economists' formulae he was able to say that these resources contributed some $500,000,000 in 1965 to the economy of the Province. This is not an evaluation of the resource. It is simply an extension of what people pay for some rather limited services. You would get closer to estimating the value of the resource if you found out what people would be willing to pay, and you would still have a whole lot of intangibles, so-called non-consumptive uses, not accounted for. The resources are certainly worth plenty, but, by British standards, ours do not get much consideration.

Where waters are already degraded you should consider what their ultimate potential would be. When the Rev. McGrath settled at Erindale long ago he used to take one hundred trout in a day on the fly from the Credit. If that river had been maintained as a stream of that quality, I am sure that the fishing would be negotiable at prices comparable to Britain. During the critical years when rivers like the Credit were changing from the condition in which Mr. McGrath found them to that in which we see them now, we were much too prone to blame the change on the fact that people had taken large numbers of fish, and to shut our eyes to what was really happening. Less than twenty years ago it was still possible to see one hundred cars parked at Caledon on a Sunday in May,

where today there is nothing. The changes that were made were made without any consideration at all for the fishery. We find ourselves spending substantial public funds to establish public angling facilities which are bound to be inferior to what we have lost, and lost unnecessarily. The public has accepted pollution quite apathetically even to the point of accepting the loss of resources and the services depending on them, though they were widely used and enjoyed.

Let me suggest to you again that it is not possible to find a simpler measure of a good environment than whether fish and wildlife can thrive in it. There are societies older than ours in years that have every right to claim that they are younger and healthier because they have been able to preserve some of the freshness of youth. This happened because people had the will to do it. In the fish and wildlife business we know only too well that man was given dominion over the beasts of the field and the fowls of the air, and we are constantly reminded that he was not given dominion over himself. That is something he has to achieve.

ONTARIO POLLUTION CONTROL CONFERENCE

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"ONTARIO'S NEW APPROACH TO WATER QUALITY OBJECTIVES"

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Shortly after the Ontario Water Resources Commission was set up in 1956 it established certain objectives for water quality control in the Province of Ontario. While these objectives had a general application to all the waters in the Province, it was anticipated that in certain specific instances, influenced by local conditions, more stringent requirements might be found necessary. On the whole, these objectives have served the Province well in the pollution control program which the Commission has been carrying forward. Like all our programs, however, continual assessment must be made of their effectiveness and applicability in order to keep abreast of changing or developing situations.

In keeping with the Commission's responsibility in this regard, a new approach to water quality objectives was adopted by the Commission in June of this year. The first public announcement concerning this new approach was made at the 1967 Industrial Waste Conference held in June in Niagara Falls. Today, it is my intention to outline for you the significance of this new approach to our pollution control program, and how it is to be implemented.

Before doing so, however, I would like to give you some background information and, at the same time, make some comments about water in general. I have had occasion recently to speak to a number of groups on Canada's position in the "water world" -- and more particularly on Ontario's position. We are richly endowed with water! This fact was never brought home so forcibly to me as when I attended President Johnson's "Water for Peace" Conference held in Washington last spring. To this conference came water experts representing 73 nations of the world. The discussions included everything from a philosophical approach to water problems to highly technical deliberations. Subjects ranged from water resource planning and development to education and training, and included such topics as water and environment, water for living and water supply technology. Also discussed were the reclaiming of water, the use of water for power, navigation and irrigation, the matter of finances and pollution control. Other subjects included the organizing of water programs as well as the provision of water supplies through desalination.

Why am I taking the time to outline all these subjects? Simply to emphasize two points: firstly, the degree of refinement which has developed today in the field of water resource management, and secondly, to emphasize again how fortunate we are in Ontario in the abundance of fresh water supplies which we have at our disposal. At the Washington Conference various representatives of the emerging nations talked with considerable passion about the importance of water to their development plans. Some, indeed, came from countries where water is in such short supply that it is held in reverence! Here, in Ontario, it is in virtually unlimited abundance. Any map of Ontario reflects this abundance with its thousands and thousands of lakes and rivers in the north and in the south, of course, the Great Lakes System -- the largest body of fresh water in the world!

Abundance, however, is not sufficient in itself. Our natural resources must be wisely managed if we are to preserve their value, and derive full benefit from them. It was for this reason that the O.W.R.C. was formed in 1956 -- to develop and administer a water management program for the Province of Ontario. During these intervening years, a management program embracing both the quantity and quality of the Province's water resources has evolved as we have endeavored to keep abreast of the latest developments. More recently, we have recognized that a more flexible approach was required in order to take advantage of new developments. Hence, our announcement last spring of a change in "policy guidelines" for water quality objectives.

As I have already indicated, the present objectives for water quality control in the Province of Ontario have been in force since the Commission was formed. Only slight modifications have been made from time to time over the years. A number of general parameters have been used such as coliforms, BOD, phenols, pH, etc. Most of you are, of course, quite familiar with these objectives. Experience has shown, however, that there are a number of technical and administrative problems associated with the application of these objectives. For this reason, in late 1966, a Committee on Water Quality Objectives was formed within the Commission to undertake an appraisal of the existing objectives and examine the problems associated with their application. The Committee's task was a complex one, requiring a comprehensive review and consideration of both the basic principles and possible changes in policy. This was followed by a thorough study of the many technical areas involved. As part of this study the Committee reviewed key aspects of environmental water quality analysis and forecast, it investigated the water quality objectives employed by the various provincial, national, state and international agencies, it examined the concept of the beneficial use of water and the need for quality criteria aimed at preserving water for the desired uses. A detailed legal review was also made.

With the benefit of this investigative background, the Committee developed conclusions on its initial work as well as suggested guidelines for future policy -- including a possible timetable for completion of the revisions of the existing objectives. Together, this comprised the preliminary report of the Committee on Water Quality Objectives. The Committee is continuing its work and will be presenting a second report early in 1968. I will go into the contents of this second report later in this paper.

Turning now to the Committee's preliminary report it contains:

1. A statement on the basic objectives for water quality in Ontario;

2. The development of plans for water quality control in drainage basins where higher than the minimum requirements are needed;

3. An interim procedure for the case-by-case management of pollution problems until specific plans for the major drainage basins or systems are developed.

The work of the Committee led to the following conclusions upon which the policy guidelines have been founded:

1. An understanding of the polluting effects of both treated and untreated municipal and industrial wastes upon natural ground and surface water has, to date, been incomplete;

2. One set of quality objectives intended for application across the Province provides too broad a base for the planning of pollution control measures in areas where development is intensive or in drainage basins where low streamflows are common;

3. Although minimum requirements are helpful in many cases, these should be made more stringent in areas of intensive water use in order to make water available for all reasonable uses;

4. Objectives should be used as guides to develop alternative plans and designs for the best use of water. This in turn, will lead to care being exercised in the design and operation of waste treatment works for the protection of public health and desired beneficial uses of water, and the judicious usage of waters for waste assimilation so that the orderly growth of municipalities and industries in desirable locations will be possible;

5. Meaningful, long-term plans for pollution control in the drainage basins of the Province will require the application of systematic methods of scientific and engineering analysis.

I will now outline, in detail, the policy guidelines which have been adopted by the Commission:

<u>Policy Guidelines</u>

1. The water resources of the Province should be utilized wisely in the best interests of the people of Ontario. This will require the restoration and maintenance of water quality for the greatest possible use. Towards this end, water quality objectives shall take into consideration the use and value of water resources for public, agricultural and industrial water supplies, for the propagation of fish and wildlife, for recreational purposes, for aesthetic enjoyment and for other legitimate uses.

2. There must be a constant effort to improve the quality of water, recognizing that the improvement of the quality of water makes it available for more uses.

3. Minimum quality control objectives are set to apply to all waters of the Province. More stringent objectives can be set for any individual situation depending upon use. In the future, more stringent objectives may be set for specific drainage basins or drainage areas.

4. Beneficial uses of water are the controlling factors in determining the water quality objectives in any drainage basin. Where the use of water for the assimilation of treated wastes in a properly controlled fashion within a drainage basin is recognized as a reasonable use, it should be compatible with the other uses of that water.

5. Economic, health, aesthetic and conservation values which contribute to the social and economic welfare of an area are taken into account in determining the most appropriate use or uses of a water resource. Therefore, in the establishment of water quality objectives for specific drainage basins, the opinions of agencies or persons have an interest and/or responsibility in the present or future utilization of the water in a particular basin are solicited and evaluated.

6. For each beneficial use, there are certain water quality requirements which must be met to ensure that the water will be suitable for that beneficial use. The co-operative assistance of technically qualified persons who are specialists with regard to various water uses are sought in determining the requirements.

7. Caution must be exercised in selecting numerical values for parameters to be included in any objectives for water quality; only those values are included for which sound information on applicable levels is available. In the absence of appropriate numerical values, the objectives should consist of verbal descriptions in sufficient detail as to show clearly the quality of water intended.

8. Water quality objectives will be revised periodically as new information and conditions develop. Objectives will not be considered final or absolute since advances in scientific knowledge concerning the effects of wastes on the environment will inevitably require their improvement.

9. All wastes, prior to discharge to any receiving watercourse, will receive the best practicable treatment or control. Such treatment must be adequate to protect and upgrade water quality in the face of population and industrial growth, urbanization and technological change.

10. Water quality objectives provide an engineering base for design of treatment works by municipalities and industries. Such objectives enable municipalities and industries to develop realistic plans for new plants or expanded facilities without uncertainties about waste disposal requirements.

11. Effluent requirements based on the applicable water quality objectives for a drainage basin will be established for each user by the Commission in order to maintain acceptable water quality for all beneficial uses within the drainage basin. Requirements may be revised when necessary to allow for increasing or new uses of the waters of a drainage basin.

12. Any user who discharges wastewater that does not meet requirements established by the Commission, or otherwise impairs the quality of the water, is subject to the provisions of the O.W.R.C. Act.

Turning now to the Committee's 1968 Report it will contain:

1. A re-statement of the Policy Guidelines;

2. A definition of the basic water quality objectives applicable to all waters of the Province (the values for the parameters chosen are expected to reflect criteria for the most restrictive uses);

3. A definition of the meaning of stringent or more precise objectives and conditions under which these would apply; and

4. A definition of effluent requirements, that is, conditions under which specific effluent constraints would apply.

It should be noted that under the above arrangement where the O.W.R.C. will set the constraints to apply in the case of each user the concept of "stream classification", as it is popularly regarded, has little meaning. The key to the objectives will be that the O.W.R.C. will be able to make major inroads into the problem of environmental water quality control by developing more specific treatment plant designs and industrial waste controls tailored to the receiving water and its later use.

Water quality criteria for the following major use activities are being evaluated by the Committee at the moment: recreation and aesthetics, public water supplies, fish, aquatic life and wildlife, agricultural uses, and industrial water supplies. Also included will be criteria for ground water. Criteria for the most restrictive uses will probably appear as the basic objectives in the 1968 report. A further step in the Committee's work will be to develop actual limiting criteria for a wider range of uses in the above categories.

By adopting this new policy, the Commission has drawn attention to the need for improving control over environmental water quality and it will be imposing specific and, in most cases, more restrictive controls. In drainage basins where this approach is adopted both municipalities and industries will be required to adhere to specific effluent requirements. Where new growth and development occur, effluent requirements will become more stringent. We will reduce the "judgment factor" in granting sewage works approvals. Rather than pretend that wastewater disposal is a use that should not exist, the Commission recognizes this as a necessary use. As the Commission is responsible for the issuing of certificates of approval for all plants with effluents, it is better to know the effect of the effluent on the stream so that this may be taken into account in setting design limitations. Later, when the plant is brought into operation, the use of effluent limits will help in judging whether a plant is overloaded, in which case court action, if deemed necessary, would be simplified.

With respect to Guideline 4, which refers to the use of water for the assimilation of treated wastes in a properly controlled fashion as being a reasonable use and not a beneficial use, per se, we do have a fair degree of freedom in the eventual administrative approach which we may take in developing specific objectives and pollution control alternatives on river basins. There are three possibilities:

1. Ideally, we may seek to maintain pre-civilization water quality conditions;

2. We may maintain quality at a level required by the most critical use of the water -- meaning that, although its pristine purity may be lost, deterioration below the beneficial use level cannot be tolerated, or

3. We may establish more restrictive requirements than necessary to satisfy the beneficial uses -- to maintain a high level of quality and to meet future growth needs.

Obviously, where it is possible to incorporate a "safety factor" on streams or lakes where little use has occurred, "3." above would be very desirable. On the other hand, if the priority of beneficial use is high enough, then the objectives can be set correspondingly high. An example of this would be our requiring waters in Great Lakes harbors to meet the same criteria as waters outside the harbors (i.e. swimming criteria). While this is a feasible proposition for Ontario, Cleveland, on the other hand, would have real difficulty in this regard. As you know, the Americans have proposed the zoning of sections of the Great Lakes on their side. We believe that they are carrying the matter too far, insofar as we are concerned, and that this degree of definition on our side is unnecessary.

In short, these new objectives will give the O.W.R.C. a sharper tool with which to resolve increasing water use conflicts. The "bare bones" of the

administrative process involved would comprise:

1. A study of the water needs within a basin and the population trends;

2. A definition of changes occurring and expected to occur under varying waste load inputs;

3. A definition of limits to be placed on wastewater sources; and

4. A determination of the costs involved and a clearer understanding of the benefits derived.

How, then, is this new program to be put into effect? Until definite plans for water quality control throughout heavily used drainage basins are developed, effluent requirements will be established for individual users. This arrangement will permit determination of the effluent requirements on the basis of the effects which waste discharges have on the local water environment. It will allow reasonable use of a stream or lake for waste disposal until an overall plan for pollution control in the drainage basin can be developed, at the same time providing assurance that the approved use will be reasonably compatible with the eventual plan.

As you can appreciate, this new program will mean a substantial increase in our water quality monitoring and laboratory activities. There has already been a substantial increase in our surveillance program in the last few years. We have now completed the third year of our Great Lakes surveys with five vessels (three of which are chartered) covering all of the Great Lakes except Michigan. These have been augmented by several other boats. The largest of these, the "Monitor", a 19-foot inboard/outboard cruiser purchased by the Commission last spring, is assigned principally to harbour work. We now have a branch laboratory in the City of London, in addition to our main laboratory in Etobicoke. Others are planned for the near future. Planning and budgeting are already underway in order to initiate the necessary additional field and laboratory programs associated with this work. In the meantime, a selection of drainage basins in southern and northern Ontario, requiring the establishment of specific water quality objectives and pollution control requirements, will be made.

This morning, you have listened to a rather technical résume of the Commission's new approach to water quality objectives. What does all this mean? What effect will this have on municipalities and industries? In simple terms, it will mean a more realistic approach to waste treatment keyed to the use that is being made of the receiving waters. Under these new guidelines, treatment units can be specifically designed to meet the needs of the receiving stream.

This new policy is not stream classification but rather a scientific approach to the use of our waters based upon new trends and ideas. There will be no lowering of the objectives of water quality presently in use concerning the waters of Ontario. No change is contemplated in our present policy regarding industrial waste treatment. The Commission's waste treatment program will continue and, in fact, will be accelerated. In short, it represents a more realistic approach to water use in Ontario!

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"THE ROLE OF THE INTERNATIONAL JOINT COMMISSION IN POLLUTION CONTROL"

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The International Joint Commission is directly concerned with international water (and air) but its interest in the workings of "domestic" agencies and programs in each country is intimate and continuing. This is particularly true for Ontario because of the immense provincial "coastline" which runs all the way from the Quebec boundary below Cornwall to the western end of the Lake of the Woods. In this vast area Ontario carried the Canadian Flag and upon the efficiency of its programs rests Canada's ability to fulfill many of its international obligations.

The I. J. C. is a permanent international body consisting of three members from Canada and three from the United States. It was established to carry out the purposes of the Boundary Waters Treaty of 1909 which, in the language of the Treaty, are:

> " To prevent disputes regarding the use of boundary waters and to settle questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations, or interests of either ... along their common frontier and to make provision for the adjustment and settlement of all such questions as may hereafter arise ... "

The Commission's responsibilities under the Treaty fall into two general categories:

> The first, which is hardly relevant to the question of pollution, involves the exercise of quasi-judicial powers in approving or disapproving applications for the use, obstruction or diversion of boundary waters on either side of the line that affect the natural level or flow of boundary waters on the other side. As an example, the St. Lawrence power development, near Cornwall, required such approval in the 1950's. This responsibility extends also to works in waters flowing from boundary waters and in waters that have crossed the boundary, when such works would raise the natural level of the water at the boundary.

> The second general category of the Commission's responsibilities, and one which is assuming ever-increasing importance, is that of making investigations and studies of specific problems, when requested by either or both Governments.

Under Article IX of the Boundary Waters Treaty, either Government may refer questions or problems along the common frontier to the Commission for study and report, with recommendations. In practice the two Governments consult on the terms and then submit a joint reference. I wish to emphasize that the Commission's responsibility in such cases is to investigate, to report the facts and circumstances to Governments and to make recommendations. Action on the Commission's recommendations in each case depends on negotiations between the national Governments and subsequent action by appropriate authorities within each country.

It is by virtue of this Article of the Treaty that the Commission has become involved, at the request of the Governments, in the investigation of water pollution and air pollution problems in specific areas along the international boundary.

The Treaty does not refer specifically to air pollution and I will come back to that subject later. It makes only brief reference to water pollution but that reference is unequivocal. Article IV of the Treaty states, "It is agreed that ... boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."

The I. J. C. has been made the watch dog of the water boundaries between Canada and the United States in relation to the Treaty obligations of the two countries to prevent water pollution having trans-boundary effects.

In discharging its responsibilities, it carries out technical investigations to ascertain the facts of a situation and also holds public hearings to obtain public reaction and the views of interested persons, before preparing its report and recommendations to the Governments. The Commission conducts its investigations into pollution -- as in other questions referred to it by the Governments -- through joint teams which we call "Boards" selected from qualified experts in both countries. For this purpose it is empowered by the two Governments to call upon officials of any of the responsible departments and agencies in Ottawa and Washington.

In our pollution investigations, the provincial and state Governments concerned also provide experts from their technical agencies. These with their federal counterparts, form the integrated teams which tackle I. J. C. problems with their combined resources, which, of course, include their own expert staffs. Where the waters involved are on the Ontario "coastline" which I mentioned earlier, the provincial members of our boards are provided by the Ontario Water Resources Commission and their contributions to the over-all studies have been very substantial indeed.

It is, I believe, this arrangement that gives to the I. J. C. a special advantage. Although the Commission itself has only a very small staff, it is able to select and deploy in its investigations the most experienced and competent people in both countries and combine them in joint undertakings.

Like the Commission itself, these international boards consist of Canadian and United States sections, each with a chairman. The Board as a whole plans and co-ordinates the over-all technical investigation, which is then carried out by the appropriate agencies of government. Activities in each country are co-ordinated by the respective sections of the Board.

One of the most valuable by-products of these international investigations is the co-operation and co-ordination necessarily involved <u>in each country</u> in mounting them. As an example: for our current investigation of pollution of Lake Erie, Lake Ontario and the international section of the St. Lawrence, the Canadian Section of the Board includes experts from the Department of National Health and Welfare, the Department of Energy, Mines and Resources, the Department of Fisheries and the Ontario Water Resources Commission. Each of these departments and agencies is participating actively in the study and the necessary work has been divided among them so that the contributions they make can be most effective. The O. W. R. C. adjusted and accelerated certain of its own programs in order to fit the needs of the co-ordinated Canadian program. Recognizing the value of the Ontario Water Resources Commission's participation in the integrated study, the Canadian Section of the I. J. C. shares the costs that O. W. R. C. incurs in direct support of the international investigation. We like to

think that the habit of co-operation among departments and agencies at both the federal and provincial levels, that develops in our I. J. C. studies, often spills over into other areas of their operations.

Several speakers have pointed out that pollution is not a new problem. The I. J. C. first investigated water pollution fifty-five years ago, in the boundary waters from Lake of the Woods, through the Great Lakes to the Saint John River. It reported in 1918 that "the discharge of raw sewage into boundary waters has resulted in a situation which is generally chaotic, everywhere perilous and in some cases disgraceful." Even so, the remedial measures recommended by the Commission at that time were not acted upon.

Our report to Governments in 1950 on pollution of the Connecting Channels of the Great Lakes met with a more favorable response. The Governments accepted the water quality objectives which the Commission recommended for the Connecting Channels and authorized the I. J. C. to maintain continuing supervision over pollution of these waters to ensure realization of the objectives. This has been done since 1952, through boards of control on which there are representatives of the Federal, Provincial and State enforcement agencies having responsibilities in each connecting channel area. The boards continuously monitor the condition of these boundary waters, check on the progress of corrective measures and report regularly to the Commission. The Commission, in turn, advises the appropriate enforcement authorities of specific situations where reasonable progress towards meeting the objectives is not being made.

The Commission has been especially concerned about the continued degradation of the Niagara River. Accordingly, it will hold a Public International Meeting at Niagara Falls next January. At that meeting, the water pollution control agencies and enforcement authorities in both countries will describe the abatement programs they have underway for the Niagara and the timetables they foresee for achievement of the established water quality objectives in this international waterway. Interested persons and organizations will also have opportunity to state their views. This will assist the Commission to arrive at an informed judgment on the adequacy and effectiveness of these measures, and on additional measures that might be taken to accelerate or improve abatement.

The I. J. C. similarly investigated pollution of the Rainy River, on the Ontario-Minnesota border, in the period 1959-64. The technical studies were planned and co-ordinated by a board which consisted of experts from the federal services of the two countries, from Minnesota and from the O. W. R. C. The Commission recommended water quality objectives for the Rainy River which were subsequently accepted by the Canadian and U. S. Governments and also at the State and Provincial level. As in the case of the Connecting Channels, the Governments authorized the I. J. C. to establish and maintain continuing supervision over the waters of Rainy River, in relation to pollution. This has been done and the supervision is exercised through the Commission's International Rainy River Water Pollution Board, on which Ontario, Minnesota, Canadian and U. S. officials serve as members. Clean-up of this historic river is progressing in both countries.

I mentioned earlier that the Boundary Waters Treaty makes no reference to the subject of air pollution. Nevertheless, the Governments have availed themselves of the opportunity presented by Article IX of that treaty to refer air pollution problems to the Commission for investigation and report.

In 1960, following a lengthy and comprehensive study, the Commission reported that the air in the vicinity of Detroit and Windsor was being polluted on both sides of the international boundary to an extent that was detrimental to the general welfare of the citizens along the Detroit River and to property interests; and that ships plying the Detroit River contributed seriously to such pollution. However, because of the terms of the reference from the Governments, the Commission's recommendations had to be limited to measures to correct the vessel smoke problem. It recommended smoke emission objectives for the vessels on the river and those objectives are now reflected in regulations made under the Canada Shipping Act and in municipal ordinances on the Michigan side of the river.

The broader aspects of air pollution in the Detroit-Windsor area were covered in a reference submitted to the Commission in 1966. The air over Sarnia and Port Huron was also included. Is it being polluted on either side of the boundary by air contaminants that are detrimental to the public health, safety or general welfare of citizens, or property on the other side of the boundary? If so, from what sources and to what extent? And what preventive or remedial measures would be most practical? These are the questions which the Commission must answer.

The same reference requested the I. J. C. to "take note" of air pollution problems in other areas along the boundary which come to its attention from any source and, if appropriate, draw them to Government attention. This is a real switch! Normally Governments are the ones to refer problems to the Commission. In this case the Commission, as Mr. Stockman mentioned on Monday, is conducting a systematic review of air pollution problems along the international boundary so that it can alert the Governments to potential trouble spots and the latter can take appropriate action.

The technical studies required under this reference are being carried out by an international board, organized in a manner similar to our water pollution boards. Members of the board are drawn from the Canadian, U.S., Ontario and Michigan Health Departments. Planning and co-ordination of the studies presented many difficulties but co-operation at all levels has been wholehearted and the program is now well underway.

It seems likely that the I. J. C. is just at the beginning of a long road, as far as air pollution along the boundary is concerned. The principles and procedures developed in the course of our several water pollution investigations, however, should provide helpful guidance in our atmospheric investigations.

Because of its reliance upon local authority in both countries for the implementation of policies and enforcement, and because of the vast extent of the water and air frontier between Canada and the United States, the I. J. C. believes that the closest possible co-operation and co-ordination between it and provincial agencies is essential in the mutual interest.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"EFFECTS OF AIR POLLUTION ON CROP PRODUCTION"*

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* Contribution from the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, in co-operation with the Economic Effects Research Program, National Center for Air Pollution Control, Public Health Service, USDHEW, Cincinnati, Ohio.

It is a pleasure to be here today and participate in your conference. While the title assigned refers to crop production, my comments will be somewhat broader and refer to agriculture in general.

Not too many years ago many recognized soil erosion as a waste. Few realized how serious a waste it was. Fewer yet dared nag our conscience about it. Now the need for soil conservation is accepted, if not always practiced. Slowly, our concept of conservation in this sense has developed into not simply setting land aside, but putting it into use within the framework of sound management. Land use is beginning to accept the mantle of conservation, or, perhaps I should say conservation is accepting the mantle of land use.

Today we are concerned about the quality of the air. There are few so isolated that they have not been made aware of air pollution. There are many who talk of air conservation. There are some who speak of air use.

There are differences between the soil-land problem and the air problem. To me, the differences are less important than the interaction. What we are able to do with a piece of land still depends upon geology, topography, soil, water, and climate as well as many economic management factors. Now we are becoming increasingly aware that what we do to the air above the land also seriously limits what we can do with the land. This is why we are concerned with the effect of air pollution on agricultural pursuits. Agriculture is and will continue to be the major essential land use required by man.

Evidence of the devastating effects of air pollution upon vegetation have been around for a long time. You have had your Sudbury and your Trail. In the United States we have had our Ducktown and Anaconda. (We also had a bit of your Trail.)

These cases were the result of sulphur dioxide from smelters. The effect was to kill all vegetation over rather large areas. With a few exceptions, we are no longer completely devastating large areas with sulphur dioxide. Yet, sulphur dioxide is still a major air pollution problem affecting agriculture.

Last year in the United States almost 30 million tons of sulphur dioxide was wasted to the atmosphere. With our increased power demands the estimates for 1980 are some 70 million tons. Some of our large new power plants will, when completed, emit as much sulphur dioxide as Trail did before control equipment was installed. The stacks will be higher, and the gas stream concentration will be lower; but the tonnage of pollutant will be about the same as that at Trail.

The textbook description of sulphur dioxide injury on leaves is irregular, blotchy, interveinal necrotic areas bleached to an ivory or tan, frequently with a slight chlorosis in the intact tissue bordering the dead areas. On grasses the necrotic pattern is also interveinal so that one sees a streaked appearance. Frequently the tips of the blades die. On conifers the pattern is a rather regular tip burn, usually brown in color, extending to the base of the needle in severe cases. Frequently there is a banding of injury.

Although the textbook symptoms and field symptoms often differ, sulphur dioxide injury is one of the easiest of the phytotoxic air pollutants to identify in the field. It is identifiable with disgusting frequency around all of our major urban areas, most power plants, and many isolated industries.

We should make a distinction between injury and damage. If a pollutant marks the leaves, produces chlorosis, or changes the growth habit of a plant; this is injury. Injury is the recognizable response of the plant to the pollutant. If this marking, chlorosis, or change in growth (this injury) affects the intended use of the plant; this is damage.

Damage is not a necessary consequence of injury, or is the severity of injury always a measure of the degree of damage. Injury refers to the symptom or response. Damage refers only to the effect of the symptom or response upon desired use of the plant.

For example, a fumigation by sulphur dioxide that severely marks the leaves of a grain crop after the head was fully formed may result in little or no damage because grain yield is not significantly affected. A similar fumigation early in the season might result in considerable loss in yield and considerable damage.

Similarly, if the needles of a pine plantation developed an inch of tip burn because of an air pollutant, the degree of damage would depend upon intended use. If these trees were being grown for pulp, damage would depend upon the effect on growth. Under some conditions the damage could be negligible. If these trees were to be harvested as Christmas trees, the damage could be almost total, since marketing depends upon appearance. Of course if some clever salesman could convince the public that brown-tipped Christmas trees were "in" this year, there might be no damage, but an actual gain.

There is another less readily identifiable effect of SO_2 on vegetation. This is the matter of chronic injury. While the formal description refers to general diffuse chlorosis of the older leaves, the easiest description is that of early old age. This type of injury of course is almost impossible to identify with certainty in the field. This general symptom of early senescence is becoming more and more common in many areas. Again, the symptom denotes injury. The degree of damage is difficult to evaluate.

Another primary pollutant of considerable interest to agriculture is fluoride.

I should digress a moment and define what I mean by primary pollutant. These are materials that act upon the receptor (the plant) in the same form as they are emitted from the source. A secondary pollutant is one that has been formed or altered from other pollutants as it passes from the source to the receptor.

To return to fluoride, it too is a toxicant for plants (and animals) that has been around for a long time. In the United States and Canada our concern did not become serious until some 25 years ago. As our demands for steel, aluminum, and phosphates increased, we became increasingly aware of fluoride pollution.

Some of our iron ores contain more fluoride than others. Fluoride is used as a flux in the primary reduction of aluminum. Phosphate rock contains from 2 to 4 per cent fluoride. Fluoride in the form of HF, SiF_4, or fine particulate is an inevitable waste product from these industries; and unless careful precautions are taken, it becomes a serious air pollutant.

The action of fluoride on the plant is considerably different than that of sulphur dioxide. In the case of SO_2, acute injury occurs whenever the atmospheric concentration at the leaf exceeds a certain threshold value. As long as the concentration stays less than this threshold, acute injury does not occur. Chronic injury may occur in time.

Fluoride, however, acts as an accumulative poison in the plant tissue. Concentration in the atmosphere is of little importance; the amount that finally is accumulated in the tissue is of importance. When the concentration exceeds certain values, acute symptoms develop. We do not recognize any chronic-type injury due to fluoride.

The acute symptom is generally a marginal and tip burn (the development of necrotic tissue along the margin and tips with a tan to red-brown color). Usually there is a sharp dark line at the edge of the necrotic tissue. On grasses the injury is similar. On conifers the injury is an irregular tip burn. A few needles may show no effect, and there is usually no evidence of banding. Fluoride injury is readily identifiable in the field and is easily confirmed by tissue analysis for fluoride.

Many of our plants can tolerate rather high concentrations of fluoride in their tissue and show no effect. This is especially disconcerting in the case of many of our forage crops. Fluoride is essential to proper skeletal and dental development in all animals. As with many things, while a little is good, too much can be disastrous. In some areas cattle can graze normal looking pasture, yet develop clinical fluorosis. Analysis of the forage is the only method we have for being certain emissions are under sufficient control to protect cattle.

The atmospheric fluoride contamination of vegetation is primarily a leaf contamination. The fluoride does not find its way to seed or roots. The fluoride content in the meat of animals grazing contaminated forage is not elevated. Because leafy vegetables form such a small portion of man's dietary intake, fluorosis in humans is not known or likely to occur as a result of eating food from a contaminated area.

Other minor primary air pollutants that cause problems with vegetation are weed killers, chlorine, ethylene, dusts, and a few more. They may cause serious local problems at times. Generally, the problems are the result of carelessness or accident, and as such, they are preventable and inexcusable. Since ethylene is a common constituent of auto exhaust, we perhaps cannot dismiss it so easily. It is also part of a much bigger problem: photochemical smogs.

During the past 20 years this by-product of our modern life, smog, has become such a serious problem that some people tend to forget the classical problems of smoke, dirt, grime, sulphur dioxide, and fluoride that are still with us.

Yet, to some of you smog is still Los Angeles. Forget it! Los Angeles still has smog, but it is just one of many communities plagued with the problem. The belt from Boston to south of Washington, D.C., sometimes rivals Los Angeles for severity of smog, and the symptoms of smog injury are frequently seen on the vegetation near all of our metropolitan areas. At the present time smog is as much an inevitable consequence of urbanization as is traffic, inadequate sewers, crowded schools, and the increased use of tranquilizers.

The phytotoxicants associated with photochemical smogs are mostly secondary pollutants. The primary pollutants in smog (hydrocarbon and nitrogen oxides) have little direct effect upon vegetation, but let them stew in the atmosphere in the presence of sunlight, and new materials that are serious phytotoxicants are formed. We do not know all the reactions that take place in this stew, and we do not know all the phytotoxicants that are developed. We do know two of them.

Ozone is one. On the east coast, and probably in Toronto, ozone is the most common phytotoxicant of the smog complex. The symptoms are upper surface fleck or stipple of older leaves. With time and increased severity, these small necrotic spots extend through the thickness of the leaf. Frequently, they coalesce to form irregular blotched necrotic areas. Injury on grasses appears as streaks on the older blades. On conifers (at least, on pine), the initial stages are a banding, frequently described as pinkish, which in time may lead to fully necrotic tips.

The other known toxicant is PAN (peroxyacetyl nitrate). It produces a glazed appearance on the underside of young leaves. This is the classic smog symptom of Los Angeles. The effect on grasses is often a banding on the young portion of the leaf. The effect on conifers in the field is not well described.

Other effects are associated with the smog complex, but we are not sure of the identity of the toxic agent. There is often an ozone-like symptom seen on middle-aged leaves of plants. There is a sun-scald-like symptom associated with some plants, and there is a generalized chlorosis and early senescence.

We are beginning to recognize another symptom: poor growth, which may, in fact, be the most serious effect. Obviously, we cannot walk into a field and point to the plants and say, "That poor growth is due to smog." We can, however, grow plants in small greenhouses supplied with filtered and unfiltered air, and note the difference in growth. This is not a neat, highly definitive experiment, since we cannot duplicate field airflows, rainfall, temperature, etc. This type of experiment has been done enough times under various conditions to provide consistent evidence that the effect on growth is real and sizable. Some are beginning to talk about a 10 to 20 per cent reduction in productivity along the Eastern Seaboard, due to air pollution in general and photochemical smog in particular.

That, in brief, is the effect of air pollution on vegetation and upon agriculture. At the present time, we estimate that air pollution effects on agriculture and forestry are costing us in the United States between $0.5 and $1 billion a year. We are becoming increasingly aware that air pollution is affecting our use of land -- land that we need for agriculture, for forestry, for recreation, and for living space.

We must consider this factor in our planning. We must also change some of our concepts of air pollution effects on agriculture.

We still often tend to think of air pollution effects on agriculture as simple, single-source receptor problems. This concept was true of the old smelter problems, but few of these single-source problems are left. We now have multi-source industrial-power-urban complexes forming an interlocking network over agriculturally important areas.

The distance that air pollutants travel is the other concept that must be revised. The old single-source problems extended for a few miles downwind. Our new multi-source problems extend for 50 miles or more. The problem has simply grown faster than we realized.

Automobiles, power plants, and industry are really only secondary problems in air pollution. The primary cause is more and more people demanding more and more services in a smaller and smaller space. If we are to continue to feed, provide fiber and recreational areas to these more and more people, they will have to demand cleaner air. They will also have to be willing to pay the cost in money and services.

It is time we think of air quality as a major factor in land use. It is time we begin to practice air conservation and apply forward-looking management practices.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"FERTILIZER USE AND POLLUTION"

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Is the use of fertilizer contributing to the pollution of our soil and water resources? Certainly fertilizer use is being accused of supplying large amounts of nitrogen and phosphorus to our ground and surface waters thus contributing to eutrophication by promoting growth of algae and other water plants. Such accusations have received prominence in the local and national press.

For example, a story in the Guelph Mercury on June 22, 1966 entitled, "Pollution in Modern Farming" quotes a Boston research director speaking to the 13th Annual Ontario Industrial Waste Conference as saying "improper use of fertilizers by farmers has caused a nutrient problem in many North American lakes and streams".

The death of fish in a millpond on the Speed River was attributed by an official of the Ontario Water Resources Commission, quoted by the Globe and Mail on June 7, 1966, to "growth of algae which were probably flourishing from fertilizer elements washed into the river from farms and urban areas."

An article in the November 1, 1965 issue of Maclean's magazine entitled, "Death of a Great Lake" relates the growth of algae in Lake Erie to the use of fertilizer in Ohio (Fig. 1). In the same article it is stated that "In Rondeau Bay, for instance, ... weeds grew to the surface and, in the words of a local marina owner made the bay look like a field of wheat. Fertilizer washing off farmland has nourished the weeds to unprecedented growth."

The charge implied in these and other statements is very clear. However, the evidence presented is very circumstantial. These articles undoubtedly contain facts, but the writers have failed to relate, in the most elementary form, cause and effect. One could, I believe, show a similar relationship between the growth of algae in Lake Erie and the number of television sets sold in Ohio. No one would, however, conclude that the T.V. sets were responsible for the weed growth. Similarly, the increasing use of fertilizer does not necessarily mean increased eutrophication of our lakes and streams.

Let's look at the evidence!

To arrive at a realistic answer to our question, it is necessary to have an understanding of the reactions fertilizers undergo when they are applied to the soil.

The nutrients which cause the most concern in lake eutrophication are phosphorus and nitrogen. These fertilizer nutrients may enter our water supplies by two routes: (1) leaching through the soil to the ground water, or (2) being carried either in solution or adsorbed to soil particles by surface runoff.

Phosphorus

Phosphorus fertilizer when applied to the soil reacts very quickly to form compounds which are only slightly soluble in the soil solution. The amount of water soluble phosphorus decreases to less than 10 per cent of that applied within a few days of application[1]. Thus, there is very little vertical movement of phos-

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[1] Miller, M.H. Unpublished Data, Dept. of Soil Science, Univ. of Guelph.

phorus in the soil. This is demonstrated by the distribution of fertilizer phosphorus in a Burford loam soil to which 700 lb. P_2O_5 per acre were applied over a seven-year period (Fig. 2). There was little increase in phosphorus test below the 12 in. depth. At least a portion of the increase in the 6 to 12 in. depth can be attributed to mixing during plowing.

The phosphate content of tile drainage waters from fertilizer and unfertilized plots has been measured since 1961 by scientists at the Canada Dept. of Agriculture Soil Substation at Woodslee[1]. The six-year averages for the unfertilized and fertilized plots were 0.101 and 0.109 lb. P/ac./year, an increase due to fertilization of only 0.008 lb./ac./year.

From this evidence we can conclude that FERTILIZER USE IS NOT CONTRIBUTING TO POLLUTION THROUGH LEACHING OF PHOSPHORUS TO THE GROUND WATER.

Because there is little vertical movement of phosphorus in soil, fertilization increases the phosphorus content of the surface soil. Therefore, soil carried by surface runoff from fertilized fields will be higher in phosphorus than that from unfertilized fields. If fertilizer use is contributing to buildup of phosphorus in our water supplies, it will be in this manner.

Certainly there is considerable loss of soil from cultivated land by surface runoff. Many estimates have been made of soil losses by erosion. The problem is to determine how much of this soil reaches our streams. The movement of soil from the top to the bottom of a slope, while undesirable from a crop production standpoint, will not contribute to pollution unless the sediment is carried directly into a stream, pond or lake. Several studies of the phosphate level in streams have been conducted. Missingham (3) found that the phosphorus content of the Grand River increased by a factor of 10 when the river passed from a predominantly agricultural watershed into more populated areas. Owen and Johnson (4) measured the phosphate level in several streams flowing into Lake Ontario. The yields of P from predominantly agricultural watersheds varied between 97 and 200 lb. of phosphorus per sq. mi. per year. Two predominantly urban watersheds (Highland Creek and German Mills Creek yielded 7,000 and 9,700 lb. P/sq. mi./year. The annual yield from the Stouffville Creek which drains a predominantly agricultural watershed but receives wastes from the Village of Stouffville was intermediate. In the Highland Creek watershed, the yield of phosphorus from urban land drainage was 5 to 10 times that from agricultural land drainage. The authors concluded that agricultural land drainage made a significant contribution to the phosphate content of streams. They stated, however, that the yield could be attributed just as logically to streambank erosion.

Studies have, in fact, shown that the suspended sediment load carried by Buffalo Creek, N.Y., was reduced 40 per cent as a result of streambank erosion control measures on only 20% of the streambank within a 145 square mile watershed (2). Obviously a significant and possibly major portion of the sediment comes from stream bank erosion.

Although surface runoff from agricultural lands enriched by fertilization cannot be disregarded as a source of phosphorus in our water is obviously is much less significant than urban runoff and municipal wastes.

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[1] Aylesworth, J.W. Personal communication.

Nitrogen

The buildup of nitrogen in our streams and lakes has also been attributed to fertilizer use. The use of nitrogen in Ontario for crop production has increased eight-fold during the last 17 years. Much of this nitrogen is added in the ammonium form. The ammonium ion (NH_4^+) is adsorbed on the soil particles and therefore moves slowly in the soil. The ammonium ion is however converted to nitrate (NO_3^-) by microbial action. The nitrate ion is not adsorbed to a significant extent and is thus free to move with the soil water.

If a solution containing ammonium is passed through a soil column, very little ammonium will appear in the effluent (Fig. 3). The nitrate in the effluent will however increase rapidly after a short time due to conversion of ammonium to nitrate. If the supply of ammonium is withdrawn the nitrate is quickly washed from the soil (1).

Thus, if nitrogen in excess of that which the crop can use is applied to the soil, nitrate nitrogen will be leached to the groundwater. This has been demonstrated on plots at the University of Guelph. Two hundred pounds of nitrogen as urea (which is quickly converted to the ammonium form) were applied to corn on a Guelph loam in the Spring of 1965 (5). The nitrate nitrogen content on the surface soil was measured periodically on the fertilized and unfertilized plots. There was a rapid buildup of nitrate in the spring and early summer with a decrease during the growing season probably due to crop utilization (Fig. 4). In the early Fall, however, the fertilized plot contained a high level of nitrate. This level decreased very rapidly with the onset of Fall rains. By December 1, the level was the same as on the unfertilized plot. The nitrate nitrogen content at the 18 to 24 inch depth in November, 1965 was 80 lb. N/ac. The following April, the content was approximately 10 lb./acre. The trial was repeated in 1966 with similar results. In December, 1966 the groundwater contained 66 ppm of nitrogen in the nitrate form. When we compare this level with the 10 ppm considered to be the upper limit for human use we must conclude that at that particular time the groundwater beneath the plot was polluted. Such concentrations in a restricted volume will soon be diluted to a safe level. If, however, such conditions were applied to a large proportion of our agricultural land, we would be faced with a very serious pollution problem.

Nitrogen fertilizer is essential to crop production. No one would suggest that our farmers should not use nitrogen fertilizer. The objective, however, should be to have adequate levels of nitrogen in the soil during the growing season without having excessive levels of nitrate remaining in the fall. In the case cited, there was no increase in corn yield with the addition of the 200 lb. of N/ac. Thus the unfertilized plot in this instance provided sufficient nitrogen during the growing season without resulting in a large concentration in the soil in the fall. It is impossible to have the desired level of crop production without contributing some nitrates to the groundwater. We can, however, keep the contribution to a minimum, and I believe acceptable, level by wise fertilization practices.

Two factors are involved, namely rate and time of application. The rates of nitrogen recommended by the soil testing service which is provided by the Dept. of Soil Science in co-operation with the Ontario Dept. of Agriculture and Food are designed to give the farmer the greatest profit per acre. These rates we believe will not cause unacceptable increases of nitrates in our water supplies. A few farmers, however, use higher rates than those recommended.

These higher rates have two undesirable results. They result in reduced profits because the yield increases, if any, will not pay for the additional nitrogen. Secondly, they cause build-up of nitrate in our groundwater.

The timing of the nitrogen application is also important. We have made the point that high levels of nitrate in the soil in the Fall are undesirable. The practice of Fall application of nitrogen has many advantages for both the farmer and the fertilizer industry and is being promoted by people in the fertilizer industry both in Ontario and the U. S. as well as by some scientists in the U. S. They argue that nitrogen applied in the ammonium form in late Fall will not be converted to nitrate until Spring due to the low soil temperature. There is considerable evidence in Ontario, however, that over half of this nitrogen may be lost over Winter. There is also evidence that conversion of ammonium to nitrate does take place and that at least some of the nitrate is leached to the groundwater. Until we find a means of retaining the nitrogen in the ammonium form over Winter, Fall applications cannot be recommended. Fall application is not only less profitable for the farmer, but it increases the danger of pollution of the groundwater.

Summary

The loss of phosphate fertilizers from agricultural lands by leaching and erosion does not contribute significantly to the pollution of our water resources. The literature states definitely that industrial wastes, effluents from sewage treatment systems and septic tanks are the major sources of phosphorus.

Nitrogen fertilizers when used unwisely can contribute to an unacceptable buildup of nitrates in our water supplies. If, however, nitrogen fertilizers are applied at the rates and times recommended, crop production can be maintained at optimum levels without creating a pollution problem.

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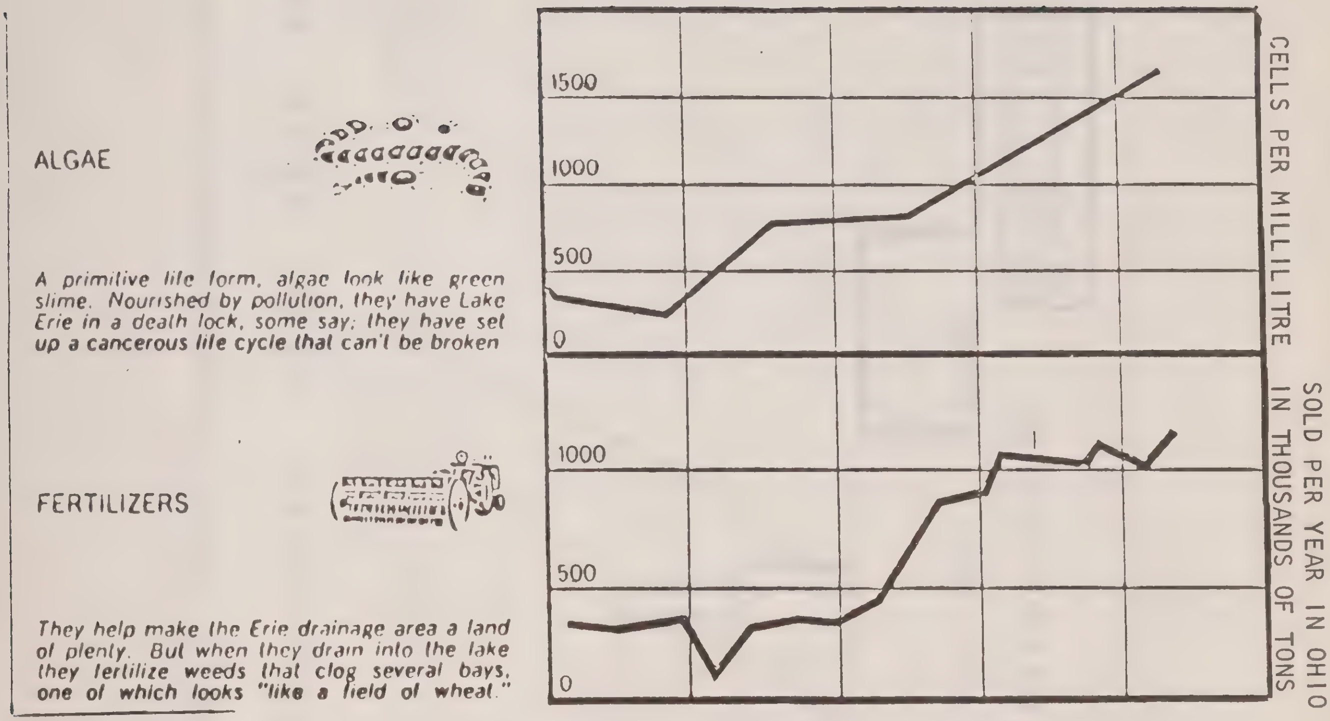

Figure 1. Reprinted from Nov. 1, 1965 issue of Maclean's magazine with permission of Maclean-Hunter Publishing Co. Ltd.

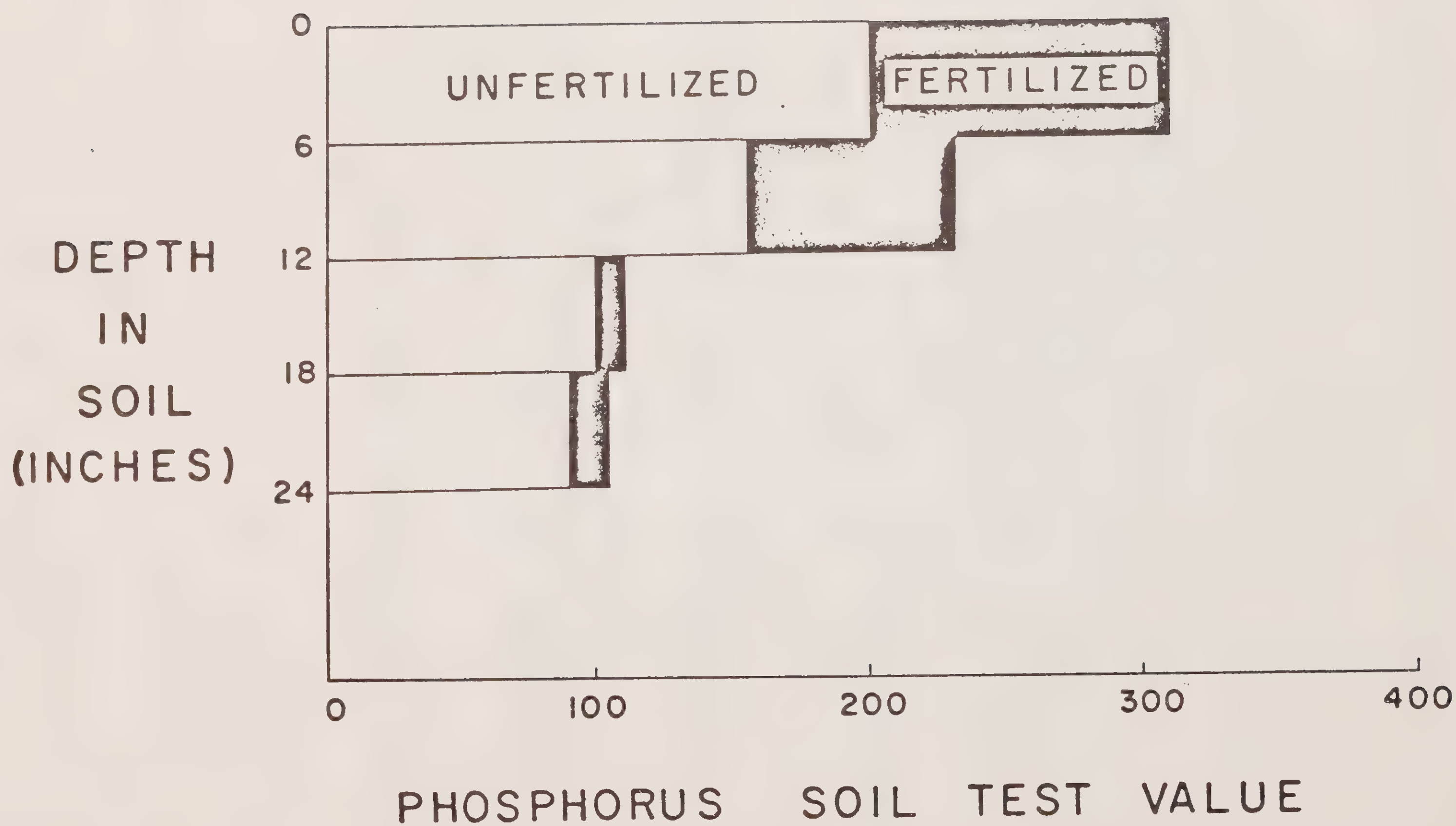

Figure 2. Distribution of fertilizer phosphorus in a Burford loam to which 700 lb. P_2O_5/ac. were applied over a seven-year period.

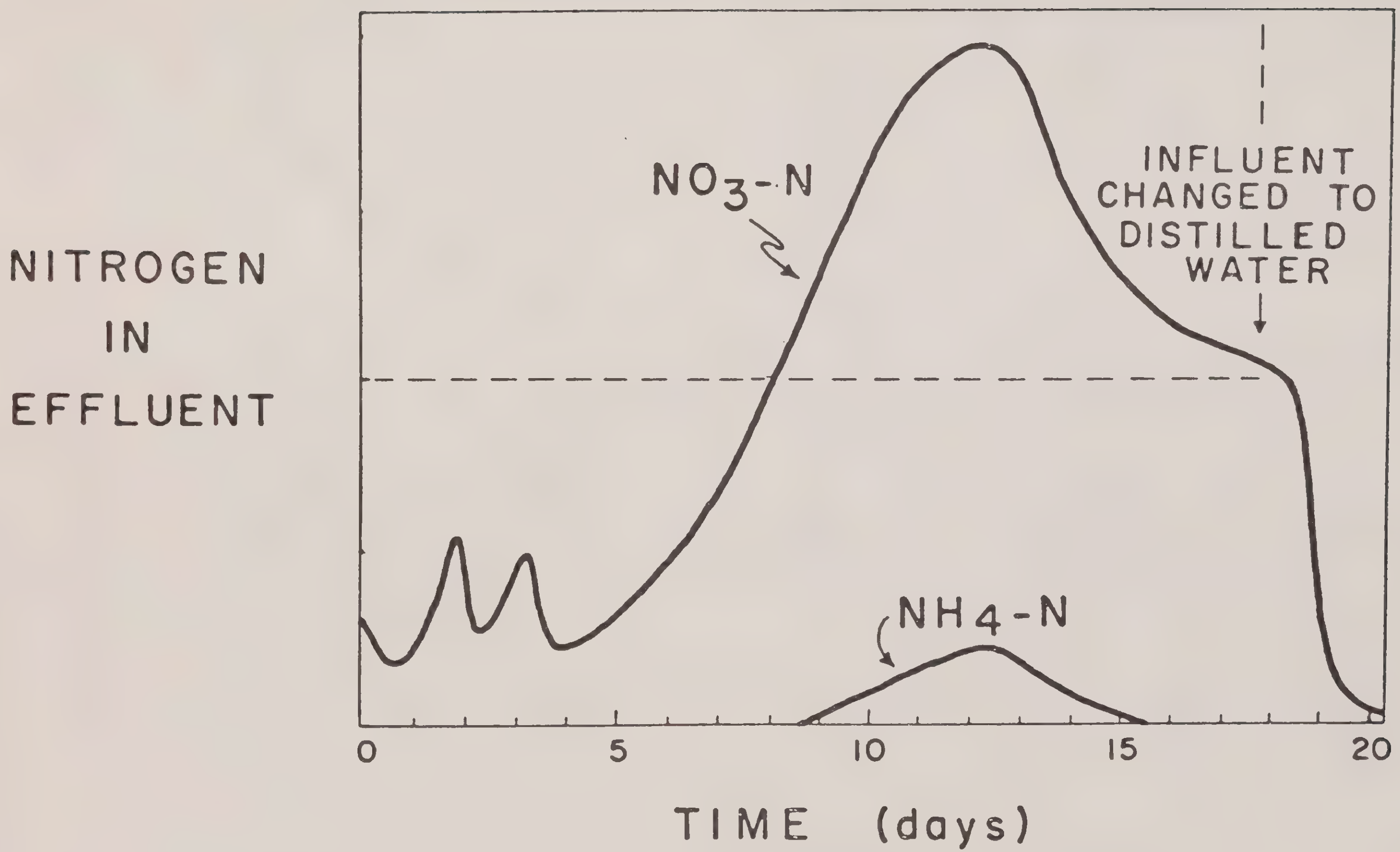

Figure 3. Nitrate (NO_3) and ammonium (NH_4) in effluent when solution containing NH_4-nitrogen was passed through soil core.

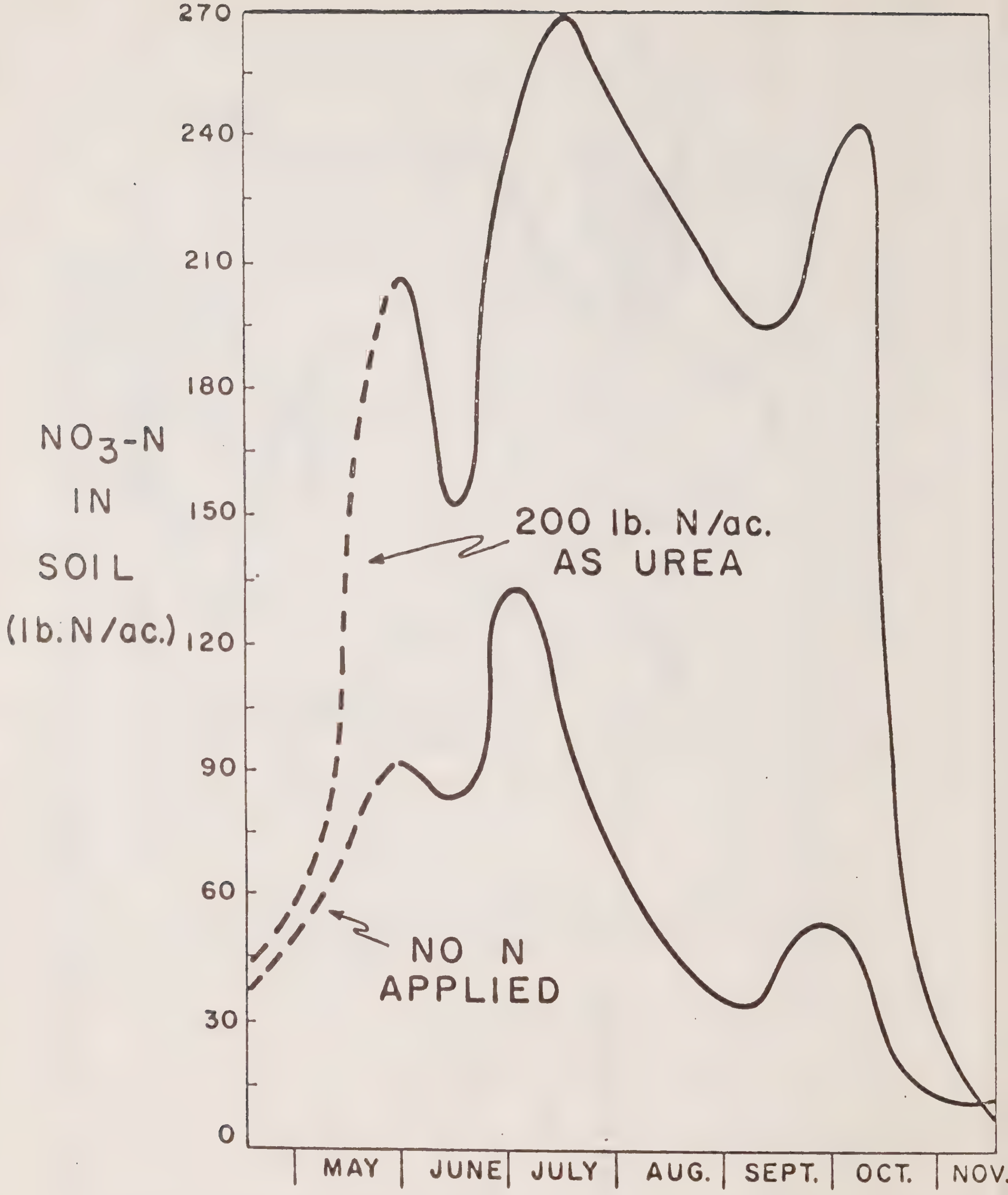

Figure 4. Nitrate nitrogen content of surface soil on fertilized and unfertilized plots.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"PESTICIDES AND OUR ENVIRONMENT"*

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In discussing the problem of possible pesticide pollution of our environment, it is first necessary to define the term "pollution" and to clearly differentiate the terms "pollutant" and "contaminant". It is difficult to define the term pollution, since the word can mean different things to different people. Perhaps it is best to accept a very broad definition such as the one put forward by the World Health Organization, i.e. "anything which may affect man's physical or mental well-being". Any pesticide which clearly affects man's physical or mental well-being would therefore be classed as a "pollutant". However, there are certain limits of environmental contamination which man can tolerate and, since it is obvious that we cannot maintain, today, an environment completely free of contamination, we must establish these tolerances. Once this is done, situations where the degree of environmental contamination exceeds the established tolerances would constitute "pollution", and the materials involved would be classed as "pollutants". However, materials present in the environment at levels below the established tolerances would be classed as "contaminants".

The furor which has arisen in recent years over the possible "pollution" of our environment by pesticides is one which is difficult to understand. Much of this furor developed after publication of the book "Silent Spring". Although this book served its purpose in that it stimulated an appraisal of the adequacy of information on pesticide residues and their persistence in our environment, many of the statements in the book were inaccurate, and many of the conclusions drawn were based on emotion rather than sound scientific logic. Unfortunately, the public's reaction is still confused, since the same urban dwellers who question the agricultural use of pesticides are responsible for the huge consumption of these same materials for home and garden use.

Literally speaking, a pesticide may be defined as "any material which will kill pests". Many people often assume that insecticides and pesticides are synonymous. Insecticides are only one type of pesticide. In addition, we have herbicides for weed control, fungicides for control of fungi, nematocides for control of nematodes, rodenticides for control of rodents, algicides for control of algae, and so on. The number of pesticides and their technical formulations number several thousand. Consequently, to attempt to cover the over-all question of pesticide contamination of our environment in this discussion would be an impossible task. Our experience in Ontario is primarily with insecticide residues, and I will limit my discussion to this aspect. I would, however, like you to keep in mind that the problems associated with insecticide contamination of our environment may apply equally well to the other groups of pesticides mentioned above.

Before 1945 the insecticides in general use were inorganic compounds, of which lead arsenate and sulphur are typical examples. In 1945 the first synthetic organic insecticide, DDT, became available for general agricultural use. This compound was the first of a series of highly effective, broad-spectrum poisons which were known as the chlorinated hydrocarbon or, more correctly, organochlorine insecticides. Typical examples are shown in Table 1. In the mid-1950's organochlorine compounds of a subgroup known as the cyclodiene insecticides became available for general use (Table 1). Subsequently, two other major groups of organic insecticides were developed, the organophosphorus and organocarbamate insecticides. The organochlorine insecticides have been used on a large scale in Canada for the past 20 years. The latter two groups of materials have been introduced more recently, and are only now beginning to command an important share of the market. At present we are concerned primarily with contamination of the environment with residues of the organochlorine insecticides, particularly DDT, aldrin, dieldrin, and heptachlor.

Table 1. Common Examples of Synthetic Organic Insecticides.

General Group	Examples	
Organochlorine	DDT BHC (lindane) toxaphene	Kelthane methoxychlor chlordane
Cyclodiene	aldrin dieldrin	heptachlor endrin
Organophosphorous	parathion malathion diazinon	Guthion Phosdrin phorate
Organocarbamate	Sevin	

Entomologists found the organochlorine insecticides to be effective against a wide variety of insect pests. In Ontario these materials were, and still are, being used extensively. They were, and still are, being applied at excessive rates, or by methods of application which were both wasteful and detrimental. In orchards, large volumes of water are applied to ensure good coverage. Unfortunately, much of the water-insecticide solution runs off the trees onto the soil. In the case of soil insects, the cyclodiene insecticides were remarkably effective control agents and, as a result, techniques of direct soil application were devised. Similarly, the organochlorine insecticides found many other uses in both agriculture and forestry and, as a result, we needlessly contaminated large sectors of our environment.

The problem of contamination of our environment with organochlorine insecticides can be broken up into three major areas: air, water and soil.

Insecticide contamination of air may occur under certain circumstances. Drift from pest control operations can result in a temporary, undesirable, and, sometimes, serious situation. In addition, volatilization of pesticide residues from the soil does occur, and in Britain it has been shown that minute quantities of some organochlorine insecticides do occur in rainwater. However, insecticide contamination of air is probably of minor importance, other than in temporary drift situations.

Contamination of water with organochlorine insecticides presents a more serious problem. Insecticides can enter surface or ground water in a number of ways. They may be discharged directly into water by: pest control spraying over water; dumping leftover insecticides directly into community sewerage or storm drainage systems; industrial waste discharges by producers of insecticides; accidental spillage along streams; or disposal of cannery wastes containing insecticide residues into watercourses. All of these are examples of contamination which can be controlled by proper enforcement. In addition, residues of organochlorine insecticides in soil, although they are only slightly soluble in water, may also contribute a low level of contamination of water as a result of runoff and erosion. We can only speculate as to the extent that our Canadian waters are contaminated with residues of the organochlorine insecticides -- we have very little actual information.

Potentially the most serious problem is that of insecticide contamination of soil. We are concerned in Ontario primarily with three insecticides -- aldrin, heptachlor and DDT.

Many people tend to assume that soil is inert, and consequently can be used as a vast dumping ground for pollutants. Unfortunately, this is not the case. The soil is an integral part of the environment, in which continuous chains of biological and chemical reactions are occurring. It harbors many types of living organisms. Consequently, when residues of organochlorine insecticides are added to the soil, they become a part of this environment, and enter into the various reactions which occur. In some cases the insecticide residues or their breakdown products remain biologically active and, as a result, can have side effects which may be deleterious. It is these side effects which are causing concern today.

The persistence and metabolism of aldrin, heptachlor, and DDT in soil has been worked on extensively. The fate of these chemicals in soil is illustrated in Table 2. Both aldrin and heptachlor are relatively volatile and, as a result, disappear quite rapidly from soil. Unfortunately, soil micro-organisms convert small amounts of aldrin to dieldrin and heptachlor to heptachlor epoxide. Both dieldrin and heptachlor epoxide are highly toxic insecticides. In contrast to aldrin and heptachlor, both metabolites are highly persistent in soil, dieldrin more so than heptachlor epoxide. DDT is itself highly persistent. It is not volatile, and is broken down only very slowly to much less toxic metabolites, DDE and DDD. The persistence and metabolism of all these insecticides is influenced by soil type, moisture, temperature, method of cultivation, and amount of crop cover over the soil surface. It would appear that residues of DDT and dieldrin will persist in the soil for many years.

Table 2. Persistence and Metabolism of Aldrin, Heptachlor and DDT in Soils.

Insecticide	Volatilization of Parent Material	Metabolites Produced as a Result of Soil Micro-organism Activity
aldrin	Approximately 90% in first 2 years	Dieldrin (approximately 10%)
heptachlor	Approximately 90-95% in first 2 years	Heptachlor epoxide (approximately 5-10%)
DDT	Nil (highly persistent)	DDE, DDD

DDT, aldrin and, to a lesser extent, heptachlor have been used extensively for control of agricultural insects in Ontario. To what extent are our agricultural soils contaminated with these materials? Recently we surveyed 36 farms in Western Ontario for residues of organochlorine insecticides in soils. While such a limited study is by no means statistically significant, the summary of the data obtained does serve as rough indication of the extent to which our agricultural soils are contaminated with organochlorine insecticide residues. It is apparent from the data shown in Table 3 that our agricultural soils are contaminated with residues of the organochlorine insecticides. The degree of contamination in most cases is not great, with total organochlorine insecticide

residues being approximately 2 ppm or less (based on a 3" acre, 1 ppm of insecticide is approximately 1 lb. per acre). In tobacco and vegetable soils, where insecticides are used extensively, the degree of contamination was greater. In orchard soils, high levels of DDT and related materials were present.

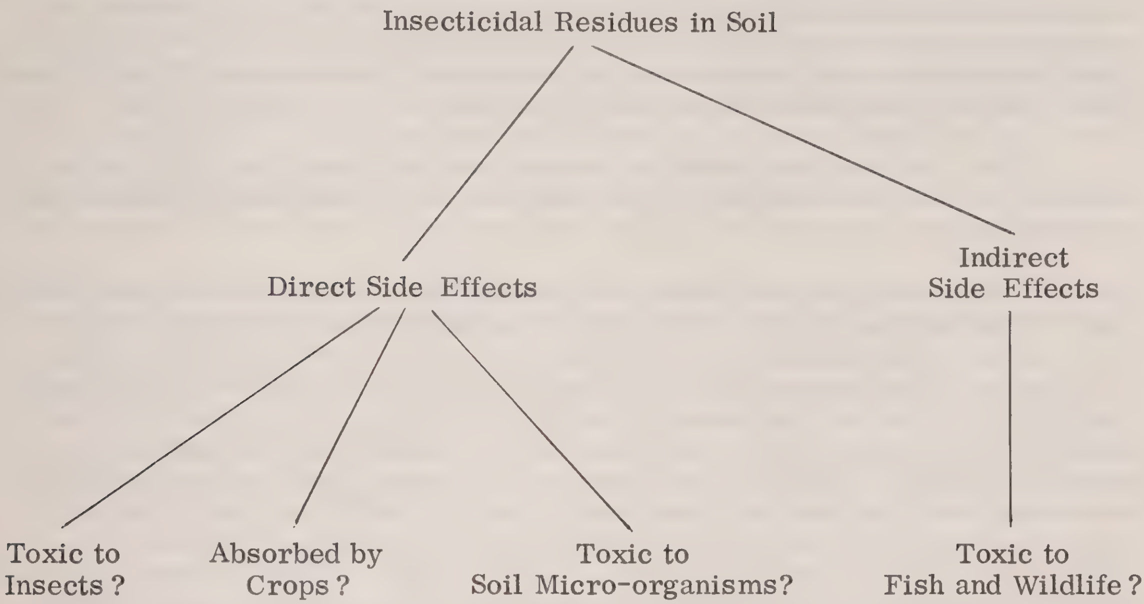
Table 3. Organochlorine Insecticide Residues in Ontario Farm Soils in Relation to Crops Grown.

Crop	DDT and Related Materials (ppm)	Cyclodiene Insecticides and Related Materials (ppm)	Total Organochlorine Residue (ppm)
Sugar beet	0.4	-	0.4
Forage and pasture	0.5	0.3	0.8
Corn	1.2	0.2	1.4
Cereal	1.4	0.4	1.8
Greenhouse vegetable	1.5	0.8	2.3
Tobacco	3.2	0.6	3.8
Vegetable	9.5	1.6	11.1
Orchard	61.8	-	61.8

Although residues of the organochlorine insecticides are present in our Ontario soils, this does not mean that they should automatically be classed as pollutants. First, it is necessary to determine if these highly persistent, toxic residues are resulting in deleterious side effects, since it is not the residues in the soil but the side effects, both direct and indirect, which are causing concern today. As shown in Figure 1, insecticidal residues in soil may have several possible side effects. In discussing them, I would like to use a "case history" which we have developed over a period of several years on one farm in Southwestern Ontario. Turnips were the major crop grown and, between 1954 and 1962, four applications of aldrin at a rate of 5 lb. actual per acre were applied for cabbage maggot control (i.e. a total of 20 lb. actual aldrin per acre over the 8 year period involved). Since small amounts of aldrin are converted to dieldrin by soil micro-organisms, it would be expected that residues of both insecticides would be present in the soil. As can be seen from the data in Table 6, chemical analysis indicated that there were about 1.5 ppm of aldrin and dieldrin in the soil. This concentration of insecticide in this particular soil type, a clay loam, would be highly toxic to all species of soil-inhabiting insects (Figure 1 on Page 191).

If insect populations were uniformly susceptible to insecticides, the residues in the soil would result in complete elimination of the insect populations and, consequently, the ultimate in soil insect control would be attained. Unfortunately, this is not the case, since the individuals in any insect population will vary in their degree of susceptibility to an insecticide. In many cases an extremely small percentage of the population will consist of individuals which are highly resistant to the insecticides. This was the case with cabbage maggots in this area. As a result of the toxic residues of aldrin/dieldrin in soil, the cabbage maggot population was subjected to "selection pressure" and, over a period of 8 years (24 generations), we eliminated the susceptible individuals in the population and selected out the ones resistant to aldrin and dieldrin. Eventually the population became totally resistant to aldrin and related materials, but not to

Figure 1. Possible Side Effects of Insecticidal Residues in Soil.



DDT or diazinon (Table 4). Thus, many of the good soil insecticides could no longer be used. In addition, the residues of aldrin and dieldrin in the soil reduced the parasite and predator populations. The end result was a population explosion of cyclodiene-resistant cabbage maggots which seriously damaged the cruciferous crops grown in this particular area.

Table 4. Toxicity of Aldrin, Related Materials, DDT and Diazinon to Adults of Cyclodiene-Susceptible and Cyclodiene-Resistant Strains of the Cabbage Maggot.

Insecticide	Strain	Lethal Causing 50% Mortality (% Solution)	Level of Resistance at ID_{50}
aldrin	susceptible	.0027	
	resistant	3.0342	X 1127
dieldrin	susceptible	.0025	
	resistant	2.4290	X 972
endrin	susceptible	.0033	
	resistant	.1161	X 35
DDT	susceptible	.0483	
	resistant	.0463	X 1
diazinon	susceptible	.0050	
	resistant	.0053	X 1

The development of resistance to the cyclodiene insecticides has not been limited solely to the cabbage maggot. In addition, at least five other species of root maggots have become resistant to the cyclodiene insecticides, both in Ontario and across Canada. The search for alternative materials to control these resistant insects has been both expensive and time-consuming, and in some cases, we still have not found satisfactory alternative control measures.

Thus, residues of cyclodiene insecticides in the soil have resulted in at least one deleterious side effect -- the development of insecticidal resistance by soil insects.

The second possible side effect illustrated in Figure 1 is the absorption of insecticidal residues in soils by crops. It has been clearly demonstrated that some crops can absorb some insecticides from soil. However, it was important to determine if crops were absorbing residues from soil under our conditions in Ontario and, if so, to what extent. Generally speaking, root crops have been found to be the plants most capable of absorbing insecticide residues from the soil. Consequently, we grew root crops on the contaminated soils on this farm, harvested them, and analyzed them for organochlorine insecticide residues. As can be seen from the data in Table 5, the crops did not absorb residues of DDT, DDE or aldrin from the soil to any great extent. However, they did absorb residues of dieldrin. Carrots absorbed dieldrin to the greatest extent, followed by radishes, turnips, and onions. <u>However, in no case did the dieldrin residues in the crops exceed the tolerances for human consumption which have been established by the Food and Drug Directorate of the Department of National Health and Welfare. The results of our studies and extensive studies by the Food and Drug Directorate and Provincial Agencies have clearly shown that insecticide residues in our vegetable crops are not exceeding the established tolerances for human consumption other than in the odd rare instance, which generally involves misuse of a pesticide</u>.

Table 5. Residues of Organochlorine Insecticides in Soil and Residues Absorbed by Root Crops (Clay Loam).

	Organochlorine Insecticide Residues (ppm[1])				
Soil - Crop	DDT	DDE	DDD	Aldrin	Dieldrin
Soil - before planting	.36	.08	-	.53	.88
- after harvest	.34	.11	-	.48	1.08
Carrots	T[2]	T	-	.02	.13
Radishes	T	T	-	T	.05
Turnips	-	-	-	-	.03
Onions	-	-	-	-	.02

[1] ppm calculated on oven-dry weight of soil and fresh weight of crop.

[2] T = trace = less than 0.01 ppm.

A second, and potentially more serious, problem involves the absorption of dieldrin residues by crops which are used for animal feed. Here we become involved with a problem known as "magnification" (Figure 2). When small amounts of dieldrin are absorbed by crops which are in turn fed continuously in

large quantities to animals, the animals tend to store the dieldrin in the crops in their fatty tissue. With continuous feeding of a contaminated crop from 10 to 25 times the concentration found in the plant may be found in milk and other animal products. As a result of this "magnification", the animal products may contain residues above the acceptable tolerances. Consequently, it was of considerable importance to determine if crops used for animal feed would absorb dieldrin from contaminated soil. As you can see from Table 6, the crops did absorb dieldrin. However, in the case of crops used extensively as animal feed, e.g. alfalfa, oats, and corn, the residues of dieldrin were minute, and it should be pointed out that residues of dieldrin in this particular soil were abnormally high.

Figure 2. Magnification of Dieldrin Residues from Soil to Animal Products.

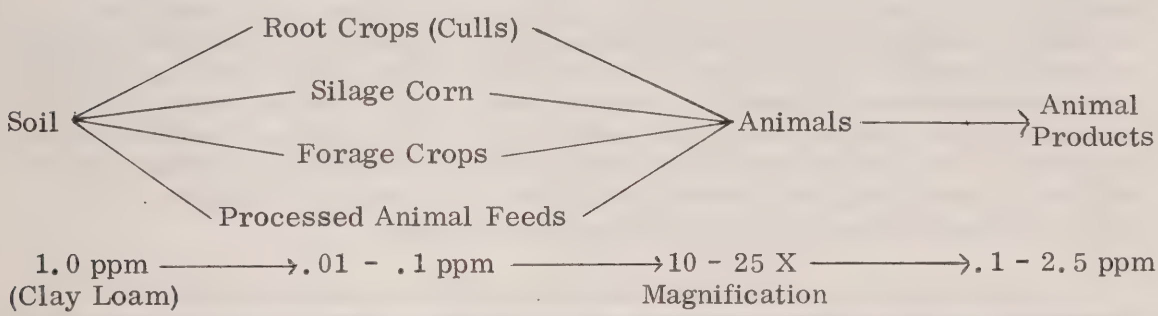


Table 6. Residues of Organochlorine Insecticides in Soil and Residues Absorbed by Crops Used for Animal Feed (Clay Loam).

	Organochlorine Insecticide Residues (ppm[1])		
Soil - Crop	DDT	Aldrin	Dieldrin
Soil - before planting	.39	.37	1.02
- after harvest	.43	.14	1.19
Alfalfa	.012	-	.016
Oats	.026	-	.016
Corn	.040	-	.016
Sugar beets (tops)	.027	-	.029
Potatoes	-	-	.030
Carrots	-	-	.037
Sugar beets (roots)	.008	-	.065

[1] ppm calculated on oven-dry weight of soil and fresh weight of crop.

Potatoes, carrots, and, particularly, sugar beets contained higher residue levels. It would appear at the present time that, provided normal feeding practices are followed, residues of dieldrin absorbed by crops used for animal feed are not sufficiently high to cause concern. In surveys across Canada and in Ontario of residues of milk and animal products, this conclusion appears warranted, since very few samples have been found to contain residues above the acceptable levels. However, cull root crops grown on contaminated land should never be fed to animals, while sugar beets should never be grown on land containing significant dieldrin residues.

The third possible side effect (Figure 1) involves the effect of insecticides on soil micro-organisms and, ultimately, on soil fertility. Present information would indicate that the organochlorine insecticides have little effect on soil micro-organisms. However, in this case, it is also necessary to consider the joint action of residues of insecticides, herbicides, and fungicides in soil on the soil microbial population. Little research has been done on this aspect.

The fourth possible side effect (Figure 1) was the indirect effect of insecticide residues in soils on fish and wildlife. It has been suggested that insecticide residues in soils are contaminating our watercourses and that, ultimately, these residues pass up through the biological chains, possibly, with magnification occurring in some instances, to fish and wildlife. It would appear that any significant degree of environmental contamination from organochlorine insecticide residues in soils is highly unlikely, since these compounds are virtually insoluble in water. Residues of dieldrin absorbed by soil particles may be eroded from the land to watercourses during spring runoff, but the insecticide remains adsorbed to the soil particles and sinks to the bottom, where it is inactivated by the mud and slowly degraded by micro-organisms. Recent studies in both the United States and Great Britain have indicated that, although fish and wildlife do contain organochlorine insecticide residues in their tissues, the levels attained are not generally sufficient to be toxic.

In this discussion I have attempted to place the question of possible "pesticide pollution" of our environment in its proper perspective. In regard to air and water pollution, it is unlikely that pesticide residues are so widely distributed, in either case, that they could be classed as pollutants. We have had specific instances of air and water pollution. However, in most cases, the pollution has been restricted to a small area and has resulted from misuse or misapplication of pesticides. In regard to pesticide pollution of soils, there is no question that our soils are "contaminated" with pesticide residues. In the case of the organochlorine insecticides, residues in the soil have resulted in the development of insecticide resistance by soil insects, and they are appearing in crops, milk, and animal products. However, generally speaking, the residues are well below the established tolerances. Thus, although we do have general contamination of our soils with insecticides, this contamination has not yet reached the point where it can be classed as pollution, nor, with proper agricultural practices, is it likely to reach this point.

At the same time, we must not dismiss the possibility of pesticide pollution of our environment. Although we now know a considerable amount about the persistence and behavior of organochlorine insecticides in soil and water, we know very little about the persistence and behavior of other pesticides such as herbicides and fungicides. Much more research is needed to clarify these aspects.

The information we have at present would indicate that, provided pesticides are used according to the recommendations, no pollution problem will occur. In nearly all cases where a pollution problem has developed, it has resulted from misuse or misapplication. I might point out that every pesticide in use is carefully evaluated by both the agricultural chemicals industry and governmental agencies before it is allowed to go on the market. However, no amount of research and regulation will be effective unless the ultimate user obeys the recommendations. In most instances one can draw up an equation to

the effect that Pesticide Misuse = Pesticide Pollution. Perhaps in the future, rather than relying on the user to follow recommendations, it will be necessary to regulate usage.

In conclusion, I would like to state quite bluntly that we cannot do without pesticides. We need them to produce, store, and process our food; to protect vast areas of forest; to protect man and his animals against disease-carrying insects; to treat imported food and fiber, to prevent the introduction into Canada of undesirable species of foreign pests; and to provide control of nuisance pests, e.g. mosquitoes and black flies, so that man can enjoy his leisure time. In recent years there has been a great deal of publicity and discussion over "non-pesticide" methods of controlling pests, such as "biological control" or "organic farming". The simple fact is that, other than in isolated instances, these techniques are either impractical, too expensive to be economical, or in a preliminary research stage which may require years for development to the practical level. Pesticides are with us to stay. Their assets greatly outweigh their liabilities. We must simply learn how to use them properly, and how to regulate and control their use.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"ANIMAL WASTE MANAGEMENT AND UTILIZATION"

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Livestock and poultry production in Ontario are complimentary to crop production and will be in the future. Historically most animal manures have been spread on the soil for crop utilization. However with intensification of production of livestock and poultry the handling and disposal of manure has become a much greater problem.

With today's large scale poultry production confinement housing is the major method for meat and egg production. Large scale confinement swine and beef operations are rapidly approaching the intensity of the poultry industry.

That an efficient agricultural industry is essential to the prosperity of Ontario and Canada no one will deny. In order that we all have the same perspective let's look at some agricultural enterprises producing a manurial waste comparable to the human excrement (not including garbage and other wastes) produced by a city of 10,000 people:

500,000 chicken broilers per year,

50,000 laying hens per year,

5,000 market hogs per year,

1,000 beef cattle per year,

500 dairy cattle per year.

Soil and Water Pollution

The nitrogen in manure can be a major contaminant of surface and ground water when excessive amounts reach the water supplies. Waters high in nitrates are a hazard to the health of animals and humans.

Nitrate poisoning of livestock from consuming silage or green forage containing excess nitrates (from either manure or fertilizer) has been known for many years.

When animal manure is applied to the soil phosphorus and potassium do not represent a problem in terms of crop production or a water pollution hazard except by soil erosion. In most cases continuous applications of manure result in a build-up of phosphorus in the soil and lesser accumulations of potassium. These levels do not interfere with crop production.

Crop Production

Fortunately in most of Southern Ontario corn is adapted and is ideal for a crop utilization system of livestock wastes. The integration of soil, manure and crops (corn, forage, potatoes, etc.) is feasible, practical and must be a major part of any production system.

Land spreading must be the method for disposal of poultry and livestock manure -- its fertilizer value being a secondary but extremely important consideration. In other words soil application has merit whether the objective is utilization or disposal. The soil provides both biological and chemical treatment that is superior to any man-devised treatment system to date.

Table 1. Nitrogen, Phosphorus and Potassium Excreted for Different Kinds of Livestock.

	Nitrogen (lb.)	Phosphate (lb.)	Potash (lb.)
1000 broilers (0 - 4 lb.) - 10 weeks	155	70	60
100 hens (5 lb.) - 365 days	125	100	55
10 hogs (30-200 lb.) - 175 days	115	65	40
2 beef (400 - 1100 lb.) - 365 days	140	65	175
1 dairy cow (1200 lb.) - 365 days	140	65	175

Table 2. Fertilizer Value of Liquid Manure Produced by Different Kinds of Livestock.

	Manure[1] (gal.)	Total Value[2] ($)	Value/1000 gal. ($)
1000 broilers (0 - 4 lb.) - 10 weeks	1000	25.50	25.00
100 hens (5 lb.) - 365 days	940	25.25	25.00
10 hogs (30 - 200 lb.) - 175 days	1510	20.00	13.00
2 beef (400 - 1100 lb.) - 365 days	3440	29.25	9.00
1 dairy cow (1200 lb.) - 365 days	3440	29.25	9.00

[1] No dilution of the manure

[2] Valuing nitrogen at 10¢ lb., phosphate at 10¢ lb., and potash at 5¢ lb.

The manure by-product should be utilized as the main fertilizer requirement for crop production. Additional fertilizer nitrogen where it is not required may increase the pollution hazard.

To eliminate ground and surface water pollution from manure the application rate and interval must be carefully adjusted.

Estimates are presented of the minimum acreage of land in continuous corn for the utilization of nitrogen in livestock manures as well as the minimum acreage required for pollution control.

Table 3. Utilization of Manures in an Integrated Land - Livestock System

Size of Operation	N-Excreted (lb.)	Minimum Corn Acreage Crop Utilization[1]	Minimum Corn Acreage Pollution Control[2]
100,000 broilers - 10 weeks	15,500	100	50
10,000 laying hens - 365 days	12,500	100	50
1,000 market hogs - 175 days	11,500	100	50
200 feeder beef - 365 days	14,000	100	50
100 dairy cattle - 365 days	14,000	100	50

[1] Minimum acres required in continuous corn for efficient use of manure (in terms of nitrogen).

[2] Manure application to point where corn yield is not likely to be reduced or pollution is not likely to be a problem (in terms of nitrogen). For pollution control on sandy soils which are more subject to leaching (mainly nitrogen) the continuous corn acreage should approach the minimum for crop utilization.

Air Pollution

Unfortunately for agriculture the one problem that still arises -- at least with present manure systems -- is an odor nuisance problem. It presents a challenge to our modern methods of farm operation. Any animal waste utilization system may fail eventually if the odor problems associated with storage and particularly spreading cannot be reduced. In the context of an integrated cropping system the treatment of manure must be directed primarily toward the reduction of the odor nuisance.

However, some degree of odor (air pollution?) relative to manure or other livestock odors must be tolerated. Farms are growing in production capacity and farm odors are growing in proportion. These farm operations will be the normal agricultural production operation of the future. More and more food must be produced through these efficient mass production agricultural techniques by Ontario farmers.

Agricultural research scientists will develop simple techniques to economically incorporate oxygen into these raw animal wastes, thereby partially aerating and reducing the odor to acceptable levels. The resulting treated waste will be used in crop production with a minimum of odor nuisance (air pollution?).

Storage Facilities

Where adequate land is available these animal wastes can be stored and used on the land. The manure handling facilities should be constructed and operated to prevent contamination of surface water and ground water supplies and to avoid being a hazard to both humans and animals.

The size of the storage will depend on the manure production per animal, the number of animals and the length of time the manure must be stored between land applications. Under Ontario conditions the storage requirements should be large enough for at least a 6-month storage during the period when the land is frozen, muddy or snow-covered.

There are three main liquid manure systems that have been used to some extent in Ontario:

1. Storage in a manure pit with very little digestion;

2. An anaerobic-aerobic lagoon where digestion is limited because of a limited oxygen supply; and

3. Aerobic digestion of a highly diluted waste where oxygen supply is adequate.

Manure Pit Storage

For the most part a manure pit is storage only, with very little microbiological breakdown. In the liquid manure procedure, excrement is flushed into a large storage reservoir. The reservoir is pumped out periodically and the liquid is applied to crop land. There is however, often an odor problem, especially when the waste is being moved or spread. Such a system will save almost all of the excreted nutrients including organic matter, hence it represents an excellent method for the well-integrated land-crop-livestock system. The key to the use of such a system seems to be adequate storage so that the waste can be distributed at the best time of the year (usually spring) for crop production while at the same time mixed with soil to eliminate the odor problem.

Anaerobic and Aerobic Systems

In anaerobic-aerobic lagoons, the diluted manure wastes are partially decomposed in shallow ponds with a large surface area. As most manure lagoons in use in Ontario have only a fraction of the needed surface areas the net effect has been that these systems have operated almost exclusively as anaerobic digestion units.

Lagoons have frequently been in trouble. There are many causes for malfunctioning lagoons in Ontario: the low temperature of winter months, frequent over-loading, not enough water to dilute the waste and sludge build-up.

These causes of malfunction and the fact that with lagoons the potential supply of plant food to grow crops is not used, make such a system a rather poor answer.

Aerobic Treatment

The method consists of injecting or incorporating enough air to supply the oxygen demands for a continuous aerobic breakdown of the organic wastes. This treatment prevents the production of objectionable odors. All of the phosphorus, potassium, and many other plant nutrients are saved. The amount of nitrogen that is retained appears to be dependent on the manner in which the system is operated.

Aerobic systems are more expensive to set up and operate than manure pit storage but are probably acceptable for very large operations with land or without land or near urban developments. The method offers the possibility of treating the waste to remove the main contaminants nitrogen and organic carbon.

For most farmers with an integrated production approach, adding large quantities of water to allow complete treatment by the oxidation method does not seem justifiable.

There is no economical way at present to treat fresh undiluted manure so that all of the effluent is suitable for delivery to a stream.

Other Systems

Composting, stockpiling and dehydration of animal wastes are receiving considerable research attention. However, cost and lack of market outlets seriously limit these as significant disposal methods. For example, dehydrated poultry manure must sell for $20 to $30 per ton to recover costs for drying.

Processing animal wastes for ultimate sale does not seem at the present to be a significant avenue of manure disposal.

The possibility of algae production in lagoons and feeding the harvested algae to livestock may have future potential.

Summary

1. There is no economical way at present to treat fresh undiluted manure for disposal directly to streams.

2. Where adequate land is available animal wastes can be used on the land.

3. Land spreading must be the method of ultimate disposal of animal wastes.

4. Soil application is the answer for the future whether the objective is utilization or disposal.

ONTARIO POLLUTION CONTROL CONFERENCE

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"THE STATE OF THE ART OF INDUSTRIAL WASTE TREATMENT"

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Introduction

"The State of the Art of Industrial Waste Treatment" is an interesting subject for a paper, at a time when pollution of our natural waterways by industrial wastes has been recognized as one of the most challenging and difficult problems facing us today. In this presentation, I propose to point out the need for a new breed of sanitary engineer and other skilled disciplines in this specialized field of pollution abatement. The terminology relation to industrial waste treatment is examined, the present state of the art or technology is discussed and existing adequacies and inadequacies are outlined.

The Water Pollution Engineer

Industrial waste treatment is a relatively new field of endeavor and has come into prominence over the past two decades. On the other hand, principles and guidelines for the treatment of domestic wastes have been in existence since the turn of the century and a large number of these are still being used today. These guidelines have proven to be quite adequate in the treatment of domestic sewage.

Over the first half of this century, little progress was made in advancing and improving treatment methods for industrial wastes. The pressing problem was related to good control of domestic sewage because of the associated public health hazards. However, with the growth of large industrialized urban areas, the character of sewage arriving at treatment plants changed appreciably with subsequent adverse effects on the efficiency of the treatment processes.

Therefore, with the introduction of industrial wastes into sanitary sewers, the old guidelines began to require modification. Also, with the increasing emphasis on industrial waste treatment for plants situated on the shores of rivers and lakes, the sanitary engineer was looked to for guidance in this field.

However, the near-stagnant state of the science, the tremendous post-war upsurge in industrialization and urbanization and the diverse problems associated with this growth threatened to make the typical sanitary engineer obsolete. He has been described as a conventional man in an unconventional world. However, the need for action usually breeds reaction and the profession has been making a tremendous effort to upgrade and revitalize its image and capabilities.

Together with the revitalization of the sanitary engineering profession, the need for new experts in associated disciplines were required to meet this unconventional challenge of water pollution. Thus, in particular, the chemical engineer has made a significant contribution in the field of industrial waste treatment. Other professionals such as biologists, bacteriologists and microbiologists are making their presence felt. After all, bacteria (like humans) are living organisms and have certain likes and dislikes. Obviously, the art of cultivating and satisfying the right type of bacteria to obtain optimum removal efficiencies in treatment processes is the work of a specialist.

Thus, industrial waste treatment requires a pool of highly skilled specialists. The sanitary engineer is rapidly becoming a water pollution

engineer with a better knowledge of the complex interrelationships in the aquatic environment and, in fact, he is becoming an environmental engineer.

Terminology

Processes for the treatment of municipal sewage are conventionally described as primary, secondary and tertiary treatment. This terminology has been carried over into the field of industrial waste treatment; however, although such terms are generally applicable and acceptable in the treatment of municipal wastes, their use in the industrial field is limited. In fact, such traditional concepts can often be misleading in seeking suitable approaches to the treatment of complex industrial wastes.

For example, to speak of primary and secondary treatment of pulp and paper mill wastes by simply thinking of the reduction of suspended solids and BOD in mill wastes is of little value in considering the problem for design purposes. Segregation of waste sewers, water re-use and conservation, removal of settleable and non-settleable solids from certain streams and BOD from others, elimination of toxic and odor-producing waste components, foam reduction, etc., call for an open-minded approach to the problem. Certainly, conventional guidelines are useful, but each type of industry has to be considered on its own and its individual treatment requirements assessed.

Engineers involved in the treatment of industrial wastes are moving towards describing the treatment system by unit operations and processes. Terms such as screening, centrifugation, activated sludge and chemical oxidation are being used to describe a series of discreet steps. Thus, the trend is away from broad terminology such as primary and secondary treatment. I might add that even in the field of municipal pollution control, the term "secondary treatment" is hardly applicable anymore, as it may mean one or a combination of a dozen possible methods of biological treatment. Incidentally, the term "tertiary treatment" has still to be defined adequately and I have seen the term "quaternary treatment" used in some publications.

To sum up, the terminology for treatment processes is becoming more exact because of the complexity of industrial waste problems.

Present Status of Technology

It would be fair to say that present day technology can provide solutions for any specific pollution problem. This current state of the technology will vary with the type of problem. However, this is not to say that all pollution problems can be solved successfully. On the contrary, a large number of these problems are currently insoluble because the solutions are economically unacceptable.

A large number of pollution abatement tools and practices are available: in-plant control, suspended solids removal operations, chemical treatment, biological oxidation, land disposal, etc. A brief review of some of the main areas of control are given below:

1. In-Plant Practices

In-plant practices cannot properly be called waste treatment practices. However, they bear such great relationships to the scope and magnitude of the final effluent to be treated, that such practices are essential in pollution abatement. Invariably, great savings are to be made to industry through such avenues as water re-use, water conservation and by-product recovery. There are examples of industries where such practices have reduced the waste loadings to be treated by as much as ninety per cent. Therefore, the obvious savings in terms of smaller waste treatment plants and lower operating expenses have also been substantial.

In-plant control is being practised more frequently by industries today; in fact, very few industries can afford to neglect such an important step and still continue to remain competitive. In many cases, in-plant control has been brought about by the threat of legal action by pollution control authorities. Corporations have begun to realize that pollution control is an indisputable necessity if civilization is to survive and that in-plant control is the very first phase of this control process.

2. Removal of Suspended Solids

This operation is largely dependent upon the types of solids and the process from which they originate in the industrial plant. For example, in fine paper production, talc is deliberately kept in suspension by dispersants, while the opposite mechanism is required in the waste treatment plant. Every application therefore invariably requires some research into the best form of treatment. Settling in clarifiers with or without chemicals, centrifuging, screening or filtering by a variety of ways all have to be looked at and the most efficient, economical operation chosen. Without going into any great detail, the distinction of suspended solids into settleable and non-settleable solids is very important in the application of solids removal technology in order to meet objectives set for effluent discharges to watercourses.

The theories of the above unit operations are quite well developed and application to the design problem is not usually difficult. However, economic solutions are still being sought in certain fields such as the removal of bark fines in pulp and paper mill effluents.

3. Removal of Soluble Organics

Biological treatment continues to be the cheapest and simplest method of removing BOD-exerting materials in wastes. The changing nature of municipal sewage and the need for this form of treatment in industrial pollution control as brought into being a myriad number of refinements to this process. Extended aeration, oxidation ditch, aerated lagoon and contact stabilization are all forms of biological treatment.

Continued research goes on in this field. After looking at oxygen transfer, optimum sizes of tanks and basins, types of aerators, etc., including all possible physical and chemical variables, a different approach is now being taken. Microbiologists and bacteriologists are

entering the picture in an effort to understand the "bug", to determine his type, to please him, to up-grade his efficiency of removal of organics from solution. After all, bacteria are the most vital part of the system and our understanding of these organisms is still minimal. From these studies, great strides are likely to arise which should result in increased efficiencies of removal at reduced costs.

In summary, the present state of the art in the removal of soluble organics (by biological means) is fairly adequate. Good reductions can be obtained in most systems in which the bacteria have been acclimated and to which adequate supplies of oxygen and food are provided. However, rates of uptake may be intensified in the future.

Other forms of treatment and disposal include anaerobic digestion, spray irrigation and deep well disposal.

4. Removal of Dissolved Inorganics

Removal of dissolved inorganics require treatment other than biological, namely chemical. Again, the approach to the problem is dependent upon many factors such as the type of salt, concentration, flow in the receiving watercourse, etc.

In certain industries, the state of the art is well developed although there is always room for improvement. For example, the treatment of metal ions (such as chromium) and toxic anions (such as cyanide) in plating wastes is well documented. Segregation of wastes, oxidation and/or reduction, neutralization or pH control, and precipitation are all factors which influence the removal of these dissolved inorganics from solutions.

However, the cost of treatment can be prohibitive in other industries. For example, the removal of calcium chloride ($CaCl_2$) from effluents of soda ash plants is uneconomical at this time and no solutions are on the horizon. Recovery of the salt as a by-product for use on roads in the winter to melt snow and ice presents only a limited market. As a result, these salts are discharged to natural watercourses with gradual build-ups being experienced in the sinks.

Nutrients in industrial effluents also pose a problem, although not quite as large as in municipal plants. Oftentimes, the offending waste can be segregated and treated at the source before entering the main sewer. If phosphate is the limiting nutrient in the eutrophication or fertilization of our lakes, then phosphate control and treatment at industrial plants is certainly possible, sometimes at appreciable cost.

Greater research is required on so-called advanced methods of waste treatment; for example, osmosis, electrodialysis and so on. At this time, it appears that high costs will be the limiting factors with these treatment methods. However, these processes are being refined and used where the necessity demands such action, as for example, where shortages of water exist in certain areas in the United States. Then, the cost of treatment of water is surpassed only by the need for this vital resource and no price is too expensive.

In summary, the technology for removal of dissolved salts from industrial effluents such as chlorides, phosphates, etc., is available, but uneconomical to sustain and much research is needed in this field.

Table 1. Capabilities of Present Water Pollution Control Technology

Pollutant				Status of Development
I	Suspended Solids			
	A.	Settleable		I
	B.	Colloidal or Non-Settleable		I
II	Dissolved Solids			
	A.	Inorganic		
		1.	Total dissolved solids	II
		2.	Nitrogen compounds	III
		3.	Phosphates	II
		4.	Trace metals	III
		5.	Heavy metals	I
		6.	Acidity/Alkalinity	I
		7.	Radioactive elements	III
	B.	Organic		
		1.	BOD	I
		2.	Refractory materials	
			a. Detergents	I
			b. Pesticides	III
			c. Residues	III
			d. Industrial	III
III	Thermal Pollution			I

I The technology is now in hand to achieve generally acceptable results.

II The technology is known but practicability depends upon economics and the results required.

III The technology is clearly inadequate.

Table 2. Summary of the Status of Water Pollution Control Technology

1. In-plant control, water re-use and conservation.

2. Product modification -- by introducing pollution-reducing properties into potentially contaminating materials; e.g. hard to soft detergents.

3. By-product recovery -- e.g. the production of vanillin and alcohol from waste sulphite liquor in the pulp and paper industry.

4. Process change -- by modifying the process to prevent or reduce release of the contaminant; e.g. substitution of cyanide salt by phosphate in zinc plating.

5. Waste treatment -- treatment and removal of contaminants.

6. Dispersion -- distribution of a waste discharge over a large area of the land (spray irrigation) or into a larger volume of water (submerged diffuser outfalls).

7. Elimination -- by preventing the contaminant from entering the environment; e.g. deep well disposal.

8. Dilution -- artificial augmentation of the flows of rivers used to assimilate wastes.

9. Detention -- by holding polluted material for gradual or later release at a more advantageous time such as peak spring run-off.

10. Diversion -- by transporting the waste to another location for discharge.

A shortcoming of disposal by dispersion and dilution is that the assimilative capacities of our streams are not known well enough to permit establishment of rational limits. However, the science is developing and these capacities are to be estimated in order to permit better management of our resources in the future.

Areas of Inadequacy

1. Inadequate Knowledge of the Complex Effects of Wastes on the Environment

An understanding of the relationship between industrial pollution and the aquatic environment is at the very heart of water pollution control efforts. Only when this knowledge is achieved, can realistic criteria, objectives or standards be established for a pollutant within the environment. Then, these values become the design criteria for treatment plants. This is significant especially where millions of dollars are likely to be spent despite the lack of technical data to support the decisions on vast capital expenditure programs.

Practices such as assimilation and dilution of untreated and partially treated wastes by rivers and streams are common practices although the effects on the receiving watercourses often are not well known. Also, the effects of such compounds as pesticides, nutrients and other dissolved inorganic salts are inadequate. For example, industries on the St. Clair River point to the great flow in that river and justify the discharge of large amounts of dissolved materials because of the great dilution factor which is available. It is argued that the removal of some of these materials from the wastes would be prohibitively expensive at this time. However, one has only to look at Lake Erie, the "sink" for all these pollutants, to realize that what may be diluted out in one part of the system, can accumulate in another part of the system to produce great harm.

More basic and applied research is required to understand these complex interrelationships so as to obtain better design and operation of waste treatment works.

2. <u>Inadequate Communication of Knowledge</u>

Inadequate communication of existing knowledge among various groups is another deterrent to effective control of industrial waste pollution. Expert knowledge in pollution control can be found in universities, major government agencies and in large corporations, but often this knowledge does not filter down to smaller agencies and industry, and even sometimes this knowledge is treated as privileged information.

3. <u>Inadequate Application of Existing Technology</u>

There is usually a communication gap between the research scientists in the field of water pollution control and the engineers responsible for the design work. The research scientist's interest is likely to end before the results of his work have been expressed in a form comprehensive to the practicing engineer. Therefore, there is usually a lag between the development of technology and its application.

4. <u>Inadequate Research and Education</u>

Inadequate research and education is a factor to be recognized in Canada. An increasing number of universities are introducing training courses related to water pollution control, and this is especially true in Ontario. However, much more needs to be done in order to provide adequately trained personnel for the pressing requirements of the present and the future.

The biggest constaint on water pollution control is lack of money. Technological solutions are often unacceptable for economic reasons. Either there is little profit potential or the cost of waste treatment is uneconomical, such that a plant may have to close down. In the latter case, this action could have far reaching effects on the economy of certain areas. This is especially true in

Northern Ontario where many a town depends on one particular large industry (e.g. pulp and paper) for its existence.

There are two crying needs for situations where the installation of waste treatment facilities may cause upsets in the economy of the area. First, cost-benefit analysis must be done in order to arrive at the best solution to the community. Reduction of damage to the environment with its increased benefits versus the cost to achieve this reduction must be weighed. Obviously, the point of view that insists on complete prevention of waste disposal to the environment at very high costs which exceed the gains to society is not a very rational one. However, cost-benefit analysis is an extremely complex exercise in the field of environmental pollution and is not arrived at easily. Secondly, there is a need for financial assistance from government (federal and provincial) to ease the burden of vast capital expenditures for necessary waste treatment works by industry. It has been said in some quarters that if an industry cannot afford waste treatment that it should not be in business. Very often, the cost of waste treatment may nullify the marginal profit realized in a competitive market. It would appear that government aid in this area is a necessity.

The Economic Re-Use of Water

The economic re-use of water via the closed cycle is an important concept for the future. Because of stricter anti-pollution regulations and fiercer competition for available fresh water supplies, contaminated water will increasingly become too costly to throw away. Industry is beginning to solve this problem economically by carrying to the limit the multiple re-use of water. This is being done in areas where renovation and re-circulation of used water is actually less expensive than the total cost of withdrawing water from a source, preparing it for the varied uses in the plant, using it, treating it for disposal, and disposing it.

This concept cannot be explored in any great depth in this paper. Suffice to say, that with increased re-use of process water in the future by industry, treatment methods will be refined to an even greater extent.

Summary

Considerable technological capability exists for dealing with industrial wastes. Most of the major industrial wastes can be treated for the removal of BOD, suspended solids, heavy metals, acidity, etc. The limitations on existing capabilities are more economic than technical. However, for some pollutants such as plant nutrients and refractory organics, present processes are inadequate or too costly for immediate widespread adoption. The present research and development in these areas must be expanded.

The continuing evolution of a new breed of environmental scientists who are focusing their energies towards the complex problems of water pollution control and water resources management gives hope for the future. However, much needs to be done at an accelerated pace. Financial incentives to industry from government need to be increased in order to remove the most serious constraint on industrial water pollution control.

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"DISPOSAL OF INDUSTRIAL WASTES IN THE SOIL"

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Among the many attributes of modern civilization is the production of great quantities of wastes, of a wide variety of composition and form. Wastes are a natural product of life processes and nature is able to cope with them unless they accumulate at a very high rate due to some unusual cause. This happens whenever we are forced to dispose of our wastes collectively. Cities and industries are cases in point, where great quantities of wastes are produced, some of which is foreign, or even poisonous to the natural environment. In the past, disposal was accomplished by the simple expedient of burning or by dumping into a stream or onto a convenient plot of cheap land. Even this crude system worked fairly well until the volumes became so great that many dumps are now filled to overflowing and the streamflow is foul with a heavy load of waste.

The public shows little interest in the whole problem unless it affects them directly. In the case of municipal wastes the matter seems simple enough -- if the public wishes improvement in the system they must pay for it. In the case of industrial wastes, if the public wishes improvement in the system they expect the industry to pay for it.

Waste disposal has strong economic implications. A system can be designed to reduce any waste (other than radioactive ones) to the point where it is no longer offensive in any way, but even our affluent society cannot afford this luxury. Therefore we find it convenient and necessary to utilize the natural environment in waste disposal schemes. To say that there must be no contamination is not realistic because even our breathing is contamination of the air, swimming is contamination of the water, and fertilizing the garden is contamination of the soil. Therefore, the degree of contamination to be allowed must be carefully specified, for we can break an industry by imposing unrealistic regulations regarding waste disposal.

Many forms of contamination have no obvious harmful effects. For example, water from streams or from the ground is used extensively for cooling. When it is returned to the stream or ground it has been heated and is no longer as efficient as a coolant. This is contamination in the true sense of the word, for the water has been made less valuable to another user. For the most part though, we would not view this form of contamination with alarm.

At the other extreme is the problem of contamination by radioactive wastes which are so hazardous they can be handled only by specialists. The problem of disposal of these wastes will become increasingly severe in the future and someday may be of general concern and perhaps a political issue.

For economic reasons then, it is necessary to define what will be allowed in the way of contamination and then to utilize the natural environment in the disposal scheme. But we must understand this environment in order to take full advantage of it without causing undue or unforeseen damage. In this sense the environment becomes a natural resource in a new way -- as a mechanism and storage space for waste disposal. For the special case of disposal of industrial wastes in the soil, we should look at the nature of the wastes, the pertinent natural processes, and the likely effects of introducing such wastes into that particular environment.

You should be warned that I am a geologist, interested mainly in water resources, so my approach will surely be biased. For the present purposes I

regard the soil to be the subsurface generally and hope to show you the main factors that must be considered in any subsurface disposal of wastes.

The usual types of wastes that are produced by industries may be classified as biological, organic and inorganic chemical, and radioactive. Wastes may be present in the form of gases, liquids, solids, or as a suspension of solids in a liquid.

Biological wastes may be bacterial or viral. They are more prevalent in sewage than industrial wastes but cannot be ignored. The variety of chemical waste produced by modern industries seems endless and is increasing at such a rate that public health scientists cannot keep up in classifying and rating them. The most commonly reported inorganic chemical contaminants are salt water or brine, and toxic compounds of fluoride, chromium and nitrogen. The most commonly reported organic contaminants are gasoline and other petroleum products, detergents, and phenolic compounds (Kaufman, 1961; Middleton and Walton, 1961).

The waste may be introduced into the ground by simple dumping, by spraying, by ponding in lagoons, or by injection through deep wells. We should note for the sake of completeness that contamination can result unintentionally from poor design or by accidents. In any case we depend on the ground to hold or contain the waste. The fact that there are so few reports of contamination from subsurface waste disposal is proof of the effectiveness of the natural processes functioning in the ground. Where natural conditions are not favorable, waste disposal can lead to widespread movement of contaminants and pollution of water and soil. In order to avoid these hazards we must understand the conditions which prevent or allow the migration of contaminants underground.

The movement or retention of contaminants in the ground depends upon the nature of both the soil (or subsurface materials), and the contaminant. Movement is closely related to the movement of groundwater and retention depends on mineralogy and physical characteristics of the earth materials.

Water moves freely through permeable zones which are called aquifers or water-bearers. A well must intersect an aquifer in order to yield water. The permeability of an aquifer is due to interconnected openings which are closely related to rock type. Thus a general geological description of the subsurface materials offers important information as to their permeability. Geologic maps show the nature and distribution of subsurface materials. The maps are made by government geologists whose main concern is the evaluation of mineral resources rather than water resources. However, the water-bearing or hydrologic characteristics of the various units can be interpreted from the maps.

These maps indicate that the crystalline, granitic rocks that underly northern Ontario are overlain by a layered sequence of sedimentary rocks in southern Ontario. This sedimentary cover of sandstone, shale and limestone thickens to the south and west, until at Windsor the crystalline rocks are buried by 3500 feet of the sedimentary rocks. In some places, such as along the Niagara Escarpment, the sedimentary rocks crop out at the surface. Elsewhere we depend on drill holes for information.

If we look at a cross-section of the subsurface of this region we see that it is characterized by a layer of glacial drift which covers the bedrock. Most of

the drift can be classified as till, an unsorted, unstratified mixture of clay, sand and boulders. Associated with the till are layers of sand and gravel, deposited by ancient rivers and glacial streams. There are similar deposits on the land surface along the valleys of present day streams. Preglacial rivers that once flowed upon the bedrock surface also had sand and gravel deposits. These deposits are now buried by the drift but are occasionally encountered in drilling, and are particularly significant because they are highly permeable. Water moves freely through the openings between grains so that the material makes a good aquifer and is an important source of water.

The driving force to move water through the pore spaces is gravity, and just as water flows downhill, or in the case of pipes from high to low pressure, it will flow through pore spaces in the earth. In this case the direction of movement is dependent on pressure and elevation so the water level in a well has particular significance.

In arid regions plants consume all the water that infiltrates into the soil. In humid regions there is a surplus of soil water which percolates downward to the water table. Thus in arid regions the water table is deep, except locally where drainage is poor. In humid regions the water table is shallow and generally follows the land surface rather closely.

The depth of the water table, or thickness of the unsaturated zone, is an important factor in waste disposal. Studies have shown that one of the best places for waste disposal is at the surface where the soil is relatively impermeable and the water table is deep. Movement of contaminants from the site will be slight because of the low permeability, and the waste may be effectively contained at the surface where it decomposes quickly. If it does migrate, as a liquid or leacheate, it has to pass through the aerated zone before reaching the water table. Oxygen is present to promote further the decay of organic contaminants (Sanitary Engineering Research Lab., 1959).

A very effective mechanism for the removal of contaminants from the water is absorption. Fine grained material such as clay has a very high surface area per unit weight. The surface of the mineral particles is electrically charged and attracts oppositely charged particles to it. Many colloidal particles and organic and inorganic contaminants are removed from the water as it passes through a bed containing clay. However, the number of vacant positions on the clay particles is finite and as the positions are filled the contaminated zone must spread further. The soil within the contaminated zone then has no more capacity to hold contaminants, just as a water softener loses its capacity to exchange sodium for calcium ions. A softener can be recharged by flushing through a strong solution of brine, and similarly the contaminated soil can be flushed by a strong solution of some salt. Thus, a contaminated zone that seemed stable and safe might suddenly expand.

Radioactive wastes are disposed of in the ground in many places to take advantage of this natural exchange capacity of soil. The radioactive material is retained and this prevents migration and perhaps dangerous pollution. It has proven very effective but field research at Blind River indicates that a zone contaminated with radioactive waste might expand rapidly if displaced by some chemical in solution (Parsons, 1962). These field results confirm what was expected from laboratory and theoretical study.

Simple filtration and adsorption usually remove suspended solids and bacteria within a few feet of travel. Even where bacteria are able to migrate, lack of food and other adverse conditions in the subsurface environment usually restricts them to a narrow zone near the source. There are some conditions which allow bacterial migration and each disposal site should be checked for them. Little is known of the movement of viruses underground because they are difficult to identify and are not reported in most tests. Epidemics of infectious hepatitis have been traced to viral pollution of groundwater, but the source was not industrial waste (Vogt, 1961). In most such pollution cases the trouble is caused by utter disregard for safety measures in locating and drilling wells.

It is apparent that the soil becomes contaminated only because contaminated water moves through it, and it is further apparent that the mechanism that purifies the water contaminates the soil. The direction of groundwater movement is a critical factor.

In the unsaturated zone water movement is vertically downward toward the saturated zone. There it becomes part of the ground-water reservoir and moves according to the laws of hydraulics. The only controls are the permeability, related to rock type, and fluid potential, the height to which water will rise in a well open only at the point in question.

Groundwater potentials are highest under hills and lowest in valleys because the water table follows the land surface. Thus, water moves through the ground from the uplands areas between streams toward the stream, where it is discharged (Hubbart, 1940). The dry-weather flow of streams consists almost solely of such groundwater discharge, which must be balanced by an equivalent amount of recharge over the upland areas, in order to maintain continuity (Farvolden, 1963). The effects of varying basin geometry have been studied (Toth, 1963; Freeze and Witherspoon, 1966), and Meyboom (1966), has mapped the groundwater flow system for a large area in Saskatchewan. Depending on these controls, water may move only a short distance underground before returning to the surface as seepage into a nearby creek or swamp. Elsewhere in the groundwater reservoir, water may be moving in a regional flow system and remain underground for hundreds of years.

Water is most readily transmitted through the permeable aquifers which have large, interconnected pore spaces. Contaminants are readily transmitted through aquifers for the same reason and there are no clay particles present to remove the contaminants by adsorption or filtration. Thus the better the aquifer, the more susceptible it is to contamination. Wherever water is removed from the aquifer by a pumped well additional water is diverted toward that well. Thus a mass of contaminated water may be induced to move toward a well, through a portion of the aquifer that had not been previously contaminated. This condition and hazard prevails along all coastlines where heavy pumping of fresh groundwater causes salt water to intrude into the aquifer. On the other hand, many high capacity wells pump water from gravel aquifers near polluted streams, and the effectiveness of the aquifer in removing contaminants is truly amazing (Klaer, 1963). Waste disposal wells have the opposite effect. The high pressures used for injection cause contaminated water to move away from the well in all directions. Again, the more efficient the well, the wider the zone of contamination.

Waste disposal in the subsurface is a necessary part of our culture, and the subsurface is therefore a valuable resource. In order to understand the

consequences of exploitation of this resource we must understand the geology, the flow system, and the influence of waste on the system. To proceed with out exploitation without adequate knowledge is a risk we can't afford.

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ONTARIO POLLUTION CONTROL CONFERENCE

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"CONTROL OF RADIOACTIVE WASTES"

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Introduction - The Prewar Scene

Before 1940 there was a modest industry in radioactive materials which included such things as the mining of uranium and thorium for uses unrelated to their radioactive properties, and the extraction of radium, polonium, mesothorium and perhaps others contained active daughter elements from these ores for use in medical and commercial applications. I should also mention that atom-smashing machines made their first appearance in university laboratories during the 1930's; the by-products included some previously unknown radioisotopes in very small quantities. All these industries produced waste, and nowadays we would conclude that they had a radioactive waste management problem. Perhaps the less said about that the better. However, it would be unfair to think that such waste was always treated with no more concern than ordinary garbage; something was certainly known about the hazards of radiation, and efforts, within the competence of those days, were made to confine contamination. But even the great Lord Rutherford, father of the nuclear age, would in his hey-day have flunked a test set by present standards: when a few years ago I made a physicist's pilgrimage to his old lab in Manchester I was warned not to touch anything -- the furniture was still "hot"; and many cherish letters from him which still produce clicks in an alpha counter. The very detailed guidelines which we try to follow today emerged during and after the Second World War as a practical necessity for the protection of people working with the unprecedented, really fantastic quantities of radioactive stuff involved in atomic bomb manufacture and nuclear reactor operation. Genuine danger sharpens awareness.

So far as Ontario is concerned, the pre-war industry counted a world-famous uranium-radium refinery but no mines, some consumption of thorium compounds for gas-mantle manufacture, some radium dial painting, a brisk business in the manufacture and repair of medical radium applicators; and that was about all. There were, so far as I remember, no atom-smashers in any of our universities.

Post-War

The post-war scene here developed very rapidly. A nuclear research kingdom was set up at Chalk River, at first as a ward of the National Research Council and later as an independent Crown Company, Atomic Energy of Canada Ltd., with a payroll eventually to number several thousand. Its prime task has been to exploit the possibilities of the natural uranium-fueled, heavy water-moderated type of reactor, as a research tool, as a producer of radioisotopes for medical and commercial use, and as an energy source for large-scale electrical power generation, and it is organized into a number of divisions dealing with these separate aspects of the business. Among the many important supporting staff functions, the waste disposal service deserves mention in view of our theme: its facilities have served not only local needs but the needs of isotope-users throughout the country, and its operators have acquired a merited reputation for know-how.

Early in the 1950's Ontario Hydro began to move toward nuclear heat for electrical power generation and has now a 20 electrical megawatt demonstration plant in operation near Rolphton on the Ottawa River, a 200 megawatt plant on Lake Huron near Kincardine almost ready to deliver power, and a 2000 megawatt, 4-unit plant under construction on Lake Ontario near Pickering, just east of Toronto. Economics, both here and in many other parts of the world, appear to

favor nuclear heat, rather than petrochemical combustion, for power generation during the remaining decades of this century and beyond. Intuition to the contrary, it is hoped and believed that local pollution, even radioactive pollution, will be a smaller problem with a nuclear plant than with one which burns coal or oil. Waste management, on the other hand, is a very considerable problem.

The only other reactor operator in the Province is McMaster University, with a 5-thermal megawatt on-campus unit of the so-called swimming pool type.

Early in the 1950's Ontario responded to Washington's urgent call for raw materials for the weapons program with a rash of prospecting which culminated in the development of 14 uranium mines, most of them in the Elliot Lake area, and a few near Bancroft. Most of these closed after a few years' operation when the American contracts were terminated, or extended with severe quantity limitations. Three have continued to operate, but with an apparently inexhaustible demand for uranium as reactor fuel now looming ahead, two of the closed mines are preparing to re-open and the prospectors are out in force again.

Between the semi-refined product of the uranium mill and the finished fuel bundles ready to pop into a reactor there may intervene two major process steps. One of these is covered by the term "enrichment" meaning enhancement of the U-235 isotope in the uranium mixture; but since we have only minor requirements for enriched uranium and these are met by import, the rather fascinating subject of enrichment plants and their waste problems will not be further mentioned. The second step, and the only one of practical interest in Ontario, is covered by the term "fuel manufacture". Various forms of uranium are possible as fuels, e.g., metal, oxide, carbide, alloy, etc., but current requirements call mostly for refined oxide pellets sealed in zircalloy sheaths (called rods) and these assembled into bundles. Three companies in Ontario are actively engaged in various phases of this work, one of them being the world-famous refinery mentioned earlier. The other two are divisions of the two largest electrical manufacturing companies in Canada: it is of interest as illustrating Canadian industrial maturity that one of the latter has had some success in the competitive field of designing and marketing complete reactor plants of the Canadian type. One of the large uranium mining companies is also geared up to enter the fuel manufacturing business.

The final group in what I have called the radioactive materials industry in Ontario consists of radioisotope users and their suppliers or procurement agents. For completeness we may throw operators of atom-smashers into the same bag, for there are now several research machines in the Province which can be stretched to fit this description. The waste control problems of this group are interesting and various, but of course less impressive than those of the mining and reactor industries.

The complexity of the post-war world is nowhere better demonstrated than in the area of nucleonics. Those of us who can remember the tortoise-pace of the 1930's still occasionally rub our eyes over what has been taken in strike in the last 25 years. It is clear that, while Ontario cannot produce an example of quite everything that is new, there is plenty of food for thought in what we have.

Terminology

With the idea that it will assist some listeners to understand the problems peculiar to this subject, I will begin with a brief refresher on the jargon of the trade.

Radioactive materials are indeed materials, with quite ordinary and predictable chemical affinities and capable of manifestation in various states of aggregation -- solid, liquid, vapor, gas, dust, solution.

A radioisotope is a radioactive form of a chemical element; most elements can appear in both radioactive and stable forms, but a few possess no stable forms. Thorium sulphate is a radioactive material because of the presence of an isotope of thorium in the combination, and even though the atoms in the sulphate radical are stable.

Any sample of a radioisotope is found to decay gradually with time by transforming itself into another elemental species. In some cases the transformation leads to a radioactive form, in others to a stable form. The time factor involved in decay is known as the half-life, and is specific to the radioisotope. It is the time required for any sample to diminish by half. Some radioisotopes have half-lives of a fraction of a second; others count their existence in minutes, hours, days, and so on up to thousands of millions of years. The relevance of this to waste control is fairly obvious: if you are lucky enough to be dealing with a radioisotope of short half-life and a stable aftermath, you may be able to wait long enough for decay to solve your problem, or you may even be willing to release it into the environment, confident that it will be gone before causing any trouble. Otherwise, you may have to plan well into the future.

The curie is a unit in terms of which the quantity of any sample of a radioisotope can be measured and expressed. It really relates to the number of disintegrations or nuclear decays which take place in the sample each second. For the very long-lived isotopes of uranium and thorium, a curie represents a substantial mass of material, several tons, but by and large for the others you can think of a curie as just a pinch or smidgin of matter. From the point of view of toxicology however a curie is a very impressive quantity. For a rough rule of thimb let us class intake of one curie as lethal; intake of one microcurie (one millionth of a curie) as undesirable, possibly detrimental, but probably not lethal; and daily intake of a few picocuries (million millionths of a curie) as having no noticeable consequences.

Ionizing radiation is emitted by radioisotopes as they decay and it is this feature which accounts for the peculiar hazards. Absorption of radiation by living things results in damage at cellular level. Irradiation of tissues may occur both from external sources and from radioisotopes which have gained access to the body. As in the case of other poisons, biological material seems to survive well under certain low levels of radiotoxic stress, but deteriorates or dies under higher levels. It is all a question of what, how much, and how often.

The term natural background refers either to the low level radiation (at a rate of about 100 millirads a year) which we experience from the presence of small amounts of natural radioisotopes in our bodies and environment, or to the presence itself.

ICRP is a familiar abbreviation for the International Commission on Radiological Protection. The guidelines now used the world over for controlling external exposure to and intake of radioisotopes stem from the various recommendations of this body. They are based on clinical, experimental and theoretical data, and, to allow for residual ignorance, include a generous safety factor. They refer only to homo sapiens: if you are interested in the tolerances of other biota, you will find little or no organized information.

Uranium/Thorium Milling Wastes

This subject was brought to public notice three or four years ago by the media, but the Elliot Lake and Bancroft situation had been under observation since the beginning of mining operations by the Departments of Mines, Lands and Forests and the predecessor of the Ontario Water Resources Commission, and since early 1958 by the Radiation Protection Service in the Department of Health. The publicity provoked a special enquiry from which have so far emerged two excellent public reports* to which references can be made for more detail than I can give here.

Briefly, the question has been what to do with large bulk quantities of low-level radioactive waste remaining after removal of uranium from the ore. By low-level I mean waste containing 1000 to 2000 picocuries of natural radioisotopes per gramme, which is about 1000 times as much as occurs in average rock and soil. By large quantities I mean, in the case of the Elliot Lake Camp, 55 to 60 million tons of solids accumulated up to the year 1967. The only practical answer here as elsewhere has been to bed the material on the ground using whatever hollows, swamps, or even small lakes were available for containment, but otherwise building up impoundment dikes as you go. These beds eventually run to several hundred acres. Since the neutralized waste is piped from the mill as 15 to 30% solids (slimes and sands) there is a lot of water to be carried away and the layout must aim to place the decant as far from the waste feed as possible in order to allow sufficient settling time. The built-up portions of the bed dry out as time goes on.

Most of the radioactive material, which of course includes longer-lived uranium and thorium daughters and thorium itself, appears to be fairly tightly bound in the solids. However a small percentage is in solution and the lime neutralization does not knock it all down. Further, where water stands or flows in contact with the solids it leaches out more activity into solution. Thus the decant to the streams and lakes of the drainage area carries some dissolved radioactivity. Tests begun in 1958 by the Department of Health have demonstrated dissolved radium almost everywhere downstream from waste dumps of this kind. Latterly the mining companies have been experimenting with barium chloride treatment of the decant water. This seems to provide a decontamination factor of up to 100 for radium and perhaps other activity. This will, of course, not stop leaching of activity from bottom muds which have previously escaped downstream beyond the decant.

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* Deputy Minister Committee (1965) Report on the Radiological Pollution in the Elliot Lake and Bancroft Areas.

O.W.R.C. Interim Report (1966) on Radiological Water Pollution in the Elliot Lake and Bancroft Areas.

While Radium-226 is the most toxic radioisotope in the mixture there are half a dozen others of possible health significance. Analytical difficulties which have heretofore prevented regular assay for these are gradually being overcome and we shall hope soon to present a more complete picture.

The radium levels in many places have for several years exceeded by a small factor the ICRP's recommended maximum for populations. The customary safety factor in the ICRP figure probably makes such excesses of no real significance. The decline in mining activity and probably the barium chloride treatment have reduced some of these levels, but not all.

As a result of recommendations in the Deputy Minister Report of 1965 the O.W.R.C. has embarked on a three-year intensive investigation with radioanalytical assistance from the Department of Health. The general object is to arrive at a reliable description of pollution sources and mechanisms, with the hope of at least being able to start off on the right foot with the next uranium field that opens up. The study has devoted some attention to effects of the wastes on lake and river biota, and may have some recommendation on rehabilitating the sandy deserts of dried out tailings. New impoundment standards have already been enunciated and certainly with the benefit of hindsight more care should go into the selection of future tailings' areas than was possible twelve years ago in the fever of the big uranium rush. However, the difficulties should not be minimized: a favorable situation for disposing of large volumes of weak waste solutions exists when the catchment provides an ample volume of permeable but absorbent ground giving long trickle paths to surface streams and groundwater. This condition is unlikely to obtain anywhere on the Shield, since the soil is generally shallow and water can move only sideways. Our best chance may lie in groping for improvement in precipitation methods, while maintaining the integrity of solids impoundment. Many of the solutions in question, while a little too strong by ICRP standards, are in chemical terms extremely weak, falling in a regime where unspecifiable interferences defeat prediction. So an inspired cooking recipe may take us further than a text-book formula.

Reactor Fuel Manufacturing Wastes

The world-famous refinery, which I now mention for the third and last time, has instituted three different private dumps or disposal areas over the years and has in the course learned some lessons. The largest of its dumps contains about 50 grams of radium and a lot of other miscellaneous natural activity from uranium ore processing. Today most of its process waste comes from refining the mill product of the various uranium mines, and is therefore fairly free of anything but uranium contamination. One of the other fuel manufacturers is by agreement allowed to use this dump. Miscellaneous waste would include old air filters, cleaning mops and rags, discarded parts of process equipment, contaminated work clothes and so on. To the extent that enriched uranium is processed very strict accountability is required so that very little of this would be found in the waste.

Reactor Waste Management

If I may diverge from my topic for a moment I should like to say a word on thermal pollution, since some public criticism in the United States is being directed on this score at nuclear power stations, but not at conventional stations.

The fallacy is that one would be as guilty as the other. For example, any station, whether nuclear or coal-fired, operating at a conversion efficiency of 30% and an electrical output of 600 megawatts must get rid of 1400 megawatts of waste heat, or enough to produce a 10° F. temperature rise in a water flow of 360,000 Igpm. If this heat is dumped to a lake or river the resulting temperature rise may affect the life cycles of some biota and so upset the biologists and fishermen, but this is not the peculiar fault of nuclear steam-raising.

Reactor waste management is so large a subject that I can hope only to highlight some aspects. For this purpose I shall focus attention mainly on Hydro's Douglas Point Generating Station, on which design and construction information is fairly complete.

This station is located on Lake Huron between Kincardine and Port Elgin on a 2400 acre tract of land in rather sparsely populated country. This location reflects the early diffidence of the licensing authority, the Atomic Energy Control Board, and of its safety advisers. At the time the station was conceived confidence had still to be gained in the ability of the designers and builders to limit serious accidents, and siting policy was equally timid in the United States. Comparison with the Pickering Station now building is inevitable; the latter with 10 times the power output, one-quarter the site area, and right on Metro's doorstep!

At the station's rated electrical output of 220 electrical megawatts, nuclear heat must be generated at the rate of about 660 megawatts. This energy comes from the fissioning of the uranium fuel which in the process breaks down into radioactive materials called fission products. These include 50 or so different radioisotopes, with a range of half-lives from seconds to nearly thirty years. The total activity in the fuel core depends on the operating history, but after a sufficient time at rated power the inventory would amount to something like one thousand million curies, or an average of 300,000 curies for each of the 3,000 fuel bundles. One bundle, originally containing about 30 pounds of uranium, will thus harbor three times as much radioactivity as is dispersed through all the tailings piles at Elliot Lake. When the bundle is withdrawn after an average residence time of two years it becomes a solid waste disposal problem. The Douglas Point solution is simple and direct: spent fuel bundles are stored under water, uncanned if they are intact or sealed in cans if they show signs of leakage. The Spent Fuel Storage Bay is big enough to hold all the fuel that will be used during the life of the plant. The water serves both as radiation shield and coolant. At Pickering only seven years' storage is being provided, so something else will have to be thought of later on. It may then pay to send the fuel to Britain or the United States for recovery of plutonium values, or it may be thought economic to build a recovery plant here.

After the fuel is removed its fission product activity declines with time but not on a single half-life pattern. One per cent remaining five years after removal is the sort of figure that might apply in many cases; this is still a lot of activity.

The other waste control provisions are numerous and interesting but less dramatic since they involve only lower level wastes.

Spent ion-exchange resins used to clean activated impurities out of the primary coolant and moderator systems are blown into storage tanks in an

underground vault attached to the reactor building. The tanks are large enough to hold all the resin likely to be used during plant life. Other active solids will be consigned to permanent underground concrete structures in a fenced disposal area on the plant property. These solids include a variety of things -- wet filters, ion exchange cartridges, balable non-combustibles, incinerator ashes, and evaporator residues which can be consolidated by concreting in drums, etc. The storage structures are above the water table and are waterproofed and weather protected. Test wells at the fence line have been provided to check leakage and migration of activity. Between 10 and 1000 curies of active material would be buried here every year.

There is a rather elaborate handling system for liquid wastes. Any that contain abhorrent chemical or activity values are reduced by evaporation, concreted and buried as noted previously. The rest is diluted with uncontaminated process cooling water to the ICRP guide-level for public drinking water and discharged to the lake. Nothing is however discharged without having been monitored, mostly by in-line monitors. Water that is normally slightly active, as from sumps and floor drains, decontamination operations and laboratory sinks is held up in delay tanks to allow time for testing, decay and deliberate dilution. A proportional sampler in the final effluent stream gives opportunity for periodic system check. The total activity rejected to the lake is probably less than one curie a month.

All airborne activity leaves the plant through the main stack with the discharge of the ventilation systems serving the Reactor and Service Buildings, a total of about 60,000 CFM. Fine filtration removes dust particles down to submicron sizes. The main gaseous contaminants are Tritium (or active hydrogen) emanating from heavy water leaks, Argon-41 arising from neutron irradiation of argon in the air of the reactor vault and the shield cooling system, and off-gases from the heavy-water heat transport system. Calculations based on ICRP levels and reasonable meteorological assumptions lead to the conclusion that the release of many more thousands of curies a day of Tritium and Argon-41 than are ever likely to occur would be without moment for the health of the surrounding population. Argon-41 has a 110-minute half-life and so does not remain in existence very long. Tritium has a 13-year half-life, but a rather large ICRP limit. The off-gases include some active oxygen and nitrogen of very short half-life, and, if there are defective fuel elements, perhaps some gaseous fission products, including active iodines. The off-gases can be held up for decay before release, if necessary, and if there is serious fission product leakage it would be necessary because the permitted release rate for iodines is less than one curie a day. The exhaust air ducts in the Reactor Building are continuously monitored at more than a dozen points. A reading higher than a preset value in the main exhaust duct will automatically result in the withdrawal of air samples for test and in the closing off of air supply and exhaust systems. A continuous monitor on the stack gives a final check on effluent. Wind speed and direction instruments on a tower on the roof of the Turbine Building register in the Control Room, for assistance in tracing the effects of any significant stack release.

The radiation protection services of the federal and provincial health departments keep off-site radiation levels under observation in a well-planned joint monitoring program.

Reprocessing of Spent Fuel

AECL at one time had a plant at Chalk River in which reprocessing was carried out on a small scale but it was discontinued. With the rise of nuclear power in Ontario and Quebec it is however not impossible that a recovery works may one day be contemplated here, so a brief note is perhaps justified. Spent natural uranium fuel does not contain enough unburned Uranium-235 to be worth recovery, but it does contain plutonium built up from the original Uranium-238 content. The recovery process involves complete dissolution of the fuel, typically in nitric acid, followed by chemical separation of the plutonium (and, in the case of enriched fuel, of Uranium-235 also) and discard of the fission products. The gaseous fission products can be released after due hold-up for decay, but high level liquid waste (of the order of curies per litre) must be given indefinite shielded tank storage. There are even larger amounts of medium level liquid waste (order of a few hundred microcuries per litre) which in the United States have customarily been poured, with due precautions, into selected ground far from public water supplies. The volumes tend to stagger the imagination. The total American high level waste inventory in 1959 was 55 million imperial gallons, arising, I presume, mostly from the weapons program. At the same time, the total annual decant of medium level wastes into the ground at the Harford Works alone was about three thousand million gallons. An official U.S. forecast made in 1959 predicted that nuclear power generation would account for 30,000 electrical megawatts by 1980, necessitating fuel reprocessing capacity of 100 long tons a day and resulting in 30 million imperial cumulative gallons of high level stored waste. The accumulated fission products from all sources would amount to ten thousand million curies. While the Canadian program would be on a smaller scale, the virtually perpetual custody required for these malignant liquids makes for very grave technical and administrative problems.

Isotope Users' Wastes

All users of isotopes are licensed by the Atomic Energy Control Board. At last count there were over 500 licensees in Ontario, holding among them nearly 1,500 licences. Nearly 100% of the licensed radioactivity is in the form of large sealed sources used for medical beam therapy, commercial sterilization of vegetables and medical supplies, industrial radiography, and so on, but the number of such sources is relatively small, probably of the order of 100 at any one time. The disposal of such material when it has decayed beyond its useful term is a comparatively simple matter: it is returned to the supplier in a shielded container and he carries on from there. On the other hand, in any one year there are thousands of shipments of microcurie to millicurie amounts of unsealed radioisotopes, mainly pharmaceuticals, for medical, biological and general laboratory use. The licence instructs the user what to do with the waste, setting out what may or may not be sent to the sewer, what may be incinerated, and what must be held for decay and later official disposal, by transfer to AECL, for example. As far as sewer disposal is concerned, reliance is placed on the good faith of the user; radiation inspectors do not make regular tests on drains. Burning in a hot incinerator is regarded as a perfectly feasible method of disposing of combustible material contaminated only with Carbon-14 or Tritium: with anything else, residual activity in the ash might be cause for concern. Burial in the city dump is a quite harmless procedure for sequestering small quantities of short-lived activity, although it is sometimes difficult to convince the city fathers. The most troublesome item of all is animal carcasses

and droppings which do not improve aesthetically while being hoarded for later consignment. McMaster University is considering an incinerator for this sort of disposal. The University of Toronto and associated hospitals accumulate about 600 pounds a month of packaged low level waste which they would prefer to transfer to a local official custodian if one could be found. I gather that AECL would not be offended. The question is receiving study.

Jurisdictions

The number of different government departments involved in one phase or another of radioactive waste control is large enough that travelling together in harness tends to be a problem in itself. The Atomic Energy Control Act and Regulations, administered by the Federal Atomic Energy Control Board, is the only legislation in the country with specific bearing on safety and other control aspects of radioactive materials. However, the federal and provincial health departments have from the first been called on to play at least an advisory and inspectoral role, and provincial departments like Mines, Water Resources, Lands and Forests and Labour have not only traditional jurisdictions, but competent general legislation and the only real machinery for dealing with many of the practical problems arising. To these we must add the newly powerful Air Pollution Control Service in the Ontario Department of Health. The old days of water-tight, self-contained fields of responsibility are certainly gone, but the new days have not been here long enough to give us a feeling of complete adjustment.

Final Remarks

I have attempted to make my talk an outline rather than a severely technical exposition. For those interested in getting down to brass tacks I can highly recommend Dr. C. A. Mawson's recent, very readable book "Management of Radioactive Wastes"; he is AECL's Director of Environmental Research. Good summaries are also to be found in pamphlets numbered 10, 12, 15 and 17, of the Safety Series published by the International Atomic Energy Control Agency in Vienna, available in English.

ONTARIO POLLUTION CONTROL CONFERENCE

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"CRITERIA AND CONTROL OF AIRBORNE DISCHARGES FROM INDUSTRY"

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ONTARIO DEPARTMENT OF HEALTH.

It is appropriate that we should consider criteria and control of airborne discharges from industry as distinct from municipal emissions because industrial discharges are usually in concentrated form from a point or area source where the source itself can be readily identified and where control measures are more easily applied. This is not to imply that industry is the source of al emissions to the atmosphere, but that its net contribution to the overall air pollution problem is significant and must be controlled. There are now criteria to which in-plant industrial concentrations of specific contaminants must be controlled. These have been established on the basis of many years experience by associations and agencies concerned with the in-plant problem. Such criteria are grossly high for air pollution control because the primary emission may undergo secondary chemical reaction in the atmosphere or may react in a synergistic or anergistic manner with other pollutants from entirely different or even widely separated sources.

Everyone present at this meeting would appreciate, and many would even demand that air quality criteria be established in absolute units or magnitudes in order that their own goals were clearly set down. These criteria are currently being developed. A few will be established by regulation in the near future, but one must regard any criteria as being of a dynamic nature which will be modified as further experience and research indicate changes to be desirable. It should be clearly indicated here that air pollution exists only if a receptor -- animal, vegetable or mineral -- exists. The criteria which are being developed are receptor-oriented and frequently must be expressed as a "time-concentration" product at the receptor, rather than in terms of emission criteria. In certain special instances, for example the automobile, or industry located in highly urbanized areas, emission criteria are appropriate. Generally, however, control to meet the receptor criteria specified must be achieved by modifying the process, raw material or plant design. This attitude makes possible the introduction of scientific concepts developed and adopted by most of the control agencies in Europe and by many of the control agencies on this continent. In applying these concepts allowance is made for the physical characteristics of the emission, local meteorological factors, stack height and magnitude of the source itself.

At this point it is appropriate to turn our emphasis to the control of air pollution and to consider air quality criteria. There are few industries, if any, which do not have a discharge to the atmosphere and the effective control of airborne discharges can only be accomplished through an active control program which begins with the design and the siting of a plant. If alternatives are available, that which leads to the lowest potential for contamination in the environment should always be selected.

In the design stages the control of airborne discharges may be achieved by two methods. The first, and preferable, technique is to use a process that does not produce contaminants which must be discharged to the environment. This is, at least in part, achievable through the use of closed cycle processes, or by varying the raw materials entering the process. The second technique, applicable to those processes which do discharge contaminants, is to control the discharge through the use of collection or removal devices. There has been significant development in the field of collection and removal devices in the past few years, particularly for particulate emissions. Appropriate devices must be designed into the system in the initial stages to be most effective. Incorporation of control devices at the initial stages has the distinct advantage that installation costs may be five to ten times lower for equivalent performance.

At the receptor level a third method of control of contaminant concentrations is available to us. That is to make a sound and planned selection of building configuration and orientation in consideration of meteorological parameters, and to design a suitable method for dispersal, specifically a stack or chimney, for those contaminants which cannot be technologically eliminated. This latter technique is only a stop-gap measure however, and to some extent compensates for our lack of engineering knowledge at the process design level. Dispersion can never lead to the adequate control of air pollution in an increasingly technological economy. This is particularly true in "our world" where changes take place so quickly. THE SYSTEMS APPROACH MUST BE USED in the design of new industrial complexes.

In siting of new plants it will become increasingly important to consider the background contamination, if any, in the general region where the plant is to be located. It is not adequate to consider only those emissions from the plant under consideration because of the effects of chemical reaction, or because emissions may react with each other in the atmosphere as noted earlier. This is one of the problems in the Los Angeles area which has, to date, been largely avoided in Canada.

When choosing the specific location of the plant local meteorological and topographical features must be reviewed along with the physical arrangement of plant and surrounding structures in relation to the point of emission. In general the requirement for large quantities of fresh water to meet industrial, commercial and residential needs has led to intensive development near the shorelines of the larger lakes and in the river valleys of our Province. From an air pollution standpoint these locations are perhaps more critical than an inland location because dispersion and transport of pollutants is determined by meteorological factors which are modified or governed by the local geographical or terrain features. Near the Great Lakes, particularly during the summer months when under light wind conditions, disperson may be inadequate, the lake breeze situation is a factor which should be considered when the plant site is selected. In river valleys nocturnal and large scale inversions frequently dominate the extent of vertical diffusion. Further it has been shown that the valley flow regime frequently controls the horizontal transport and dispersion of contaminants, and almost always modifies the large scale meteorological flow patterns. Consideration of these factors, along with others relating to terrain features has led to the design and construction of stacks in excess of 1,000 feet high in Europe and the United States.

In the design of a stack or point of emission the stack load factor or turn-down ratio should be considered, especially for large heating plants in our climate where full load exists for only a very brief period each year or for industrial stacks which serve several different units. Equations for prediction of the height to which the plume will rise incorporate separate terms to account for the momentum (velocity) and buoyancy rise of the effluent emitted. The buoyancy item is usually most significant, to the point where some investigators have neglected the momentum term completely, and processes which destroy buoyancy are to be avoided. This has been clearly shown by experience in the case of the Battersea Power Station in London, England. At this station effluent washing to remove sulphur dioxide has resulted in concentrations of this gas which are higher locally than they were before the washing process was installed, even though a high percentage of the sulphur dioxide is removed and at greater distances concentrations are significantly reduced. Despite the lesser significance

of momentum rise, it is physically and theoretically unrealistic to ignore it completely and stack exit velocities should be kept as high as possible with due consideration of the stack exit diameter. Exit velocities in excess of 60 feet per second are commonly recommended for flues greater than three feet in diameter. Momentum or velocity considerations become increasingly important as exit temperature of the effluent decreases. In Europe stacks have been built with several flues in the same stack-housing in order that an adequate exit velocity can be maintained under varying load conditions. Such stacks are presently being considered in Ontario.

Finally, several mathematical models are available for estimating the downwind concentration of contaminants from a point or area source. These models can deal only with the averages of concentrations downwind under various meteorological conditions but they do provide good order of magnitude estimates for the contribution of a given source at a given point in three-dimensional space. Downwind concentrations of a contaminant, predicted using these equations, can be superimposed on measured background concentrations to predict the total concentration at the receptor level under various meteorological conditions. This type of analysis is almost essential in the competent design of a stack. IT IS ABSOLUTELY INADEQUATE to consider the emissions from a single source or to consider transport and diffusion in the immediate vicinity of that source alone -- except where this source is the only one in the vicinity. Emissions from large sources have been shown to cause damage at distances in excess of 30 miles; small sources contribute to the overall air pollution at these distances.

In closing, it is obvious that our existing level of technology can go a very long way toward the control of undesirable atmospheric contamination. There are many problems yet unsolved, particularly those related to the removal of gaseous emissions. On the other hand, if the systems approach is used and the plant is considered as an integrated part of the local environment we can control the average concentration of airborne emissions at the receptor where it counts. Under very special meteorological conditions, an air pollution build-up may still occur. Under these circumstances it may be necessary to establish regulations which will result in a reduction throughout for industrial processes during the period that these special conditions persist.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"AIR QUALITY CRITERIA AS RELATED TO MUNICIPALITIES"

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In any municipality the total emission to the atmosphere arises from a multitude of sources. A few of these are concentrated into what might be called individual point sources, but the greater number by far are smaller, diffuse sources, each of which contributes "just a little" to the overall contamination. Frequently isolated incidents can be related to the point sources of atmospheric contamination but it should also be stated that frequently the point source emissions would be tolerable if there were no existing background contamination. This type of situation, viz. many sources and many different pollutants, leads to analysis procedures which are extremely complex and to the establishment of air quality criteria which are expressed in terms of concentrations at the receptor.

Acceptable levels for in-plant concentrations of many contaminants have been developed by agencies in most countries of the world. These levels have been determined on the basis of experience using data for workers exposed to a specific contaminant for an eight hour working day. It has been clearly demonstrated that these levels are grossly high for continuous exposures in atmospheres where a multitude of contaminants are present. In London, England and Donora, Pennsylvania where air pollution episodes occurred, it was established that no single contaminant reached concentrations which approached those recommended as maximum tolerable in-plant concentrations. It is established, then, that we must consider chemical reactions of contaminants in the atmosphere, which lead to eye and throat irritation in Los Angeles, and we must also consider anergistic and synergistic (i.e. the intensifying and nullifying) effects of many contaminants in combination.

Quantitative air quality criteria for the ambient air will be established for a few of the more common contaminants in the near future. These criteria are being developed now with due consideration of factors influencing the Ontario region. In view of the complexity of the analysis required these criteria must be regarded as being of a dynamic nature and the criteria will be modified upward or downward as further experience and research indicate that changes are desirable. The criteria are based upon the effects of specific pollutants on human health, vegetation, domestic animals, nuisance and aesthetic values, and will, in many cases, be expressed in terms of a "time concentration" product at the receptor. The criteria will be receptor-oriented because without the receptor atmospheric contamination has no meaning; however, in certain instances as in the case of the automobile and visible smoke, criteria which are emission-oriented may be established as required. To account for the fact that many pollutants may interact to create a combined effect, criteria may be established as an Air Pollution Index applicable to a specific region. In such an Index the various pollutants can be weighted according to their significance in creating a total effect.

With the establishment of background air quality criteria there is inherently the responsibility to monitor air quality in the municipalities. Automatic monitoring stations are currently being prepared for Sarnia and Windsor and should be installed and operational within the next few months. These stations will monitor sulphur dioxide, oxides of nitrogen, total oxidants, carbon monoxide and hydrocarbons. In addition to these gaseous contaminants, particulates will be observed using dust fall jars for large particle fallout, high-volume filters for suspended particulates and A.I.S.I. spot samplers for the respirable particle fraction of the atmospheric dust. High volume filter samples may be analyzed for the presence of trace metals; for example, lead, or other particulate matter which may be harmful to health. Other contaminants may be

monitored in specific areas if it seems desirable or appropriate. Ultimately the information from each of these stations will be available on at least an annual basis for comparison purposes.

You are all aware that for a given and constant emission intensity in a municipality the environmental air quality is largely controlled by meteorological factors. The frequency and intensity of inversions is important in the establishment of an air pollution climatology as are local terrain or geographic features which may govern, and almost always modify, air movement and diffusion characteristics in the atmosphere. For example, the more stable lake breeze flow system near the shorelines of the larger lakes, and the valley wind systems which have been clearly documented, may result in local temporary, but uncomfortably frequent fumigation conditions which bring unusually high contaminant concentrations to the surface. To establish the air pollution climatology, a network of meteorological stations is also being established in Ontario. One station is presently installed and operating on the western outskirts of Toronto and tenders are presently being called for a second station to be located near the St. Clair River south of Sarnia. A mobile 100 foot research station is also on hand. It was used in a research investigation this summer in the Sarnia area and was moved to the Windsor area a few weeks ago.

In the past air quality and meteorological observation stations have generally been fully attended by local staff. A considerable staff complement is required for data reduction from analogue recorder charts. Today emphasis is being placed on making major observing stations fully automatic with digital data output. At present we are still installing analogue recorder back-ups at air quality and meteorological stations but it is expected that these can be eliminated in the near future. The distinct advantage of digital recording is, of course, that all data can be handled rapidly through the Department of Health's electronic computer. The observation and recording networks presently being designed are actually leading the electronics industry somewhat, especially in the field of data transmission. They are as advanced, and possibly more advanced in concept, as any system on this continent. Meteorological information will also be published as techniques for recording and handling of data become fully and routinely operational.

It is appropriate that the control of air pollution should also be considered within this discussion. Mr. Tom Cross has discussed the control of emissions to the atmosphere by means of process control and by means of contaminant removal at the source. These aspects will not be discussed further here. A third method of control for contaminant concentrations lies in the adequate transport and dispersion of contaminants which must be emitted because we lack the technological ability for their complete elimination or removal. THIS IS NOT A PARTICULARLY SATISFACTORY METHOD OF CONTROL. It is really only a stop-gap measure which, to some extent, compensates for inadequate knowledge in other areas. Today then, control of contaminant concentrations by dispersion is an essential technique in our overall program to regulate air quality in a municipality.

Several mathematical models are available for estimating the downwind concentration of contaminants from a point or area source. These models can deal only with the averages of concentrations downwind under various meteorological conditions but they do provide good order of magnitude estimates for the contribution of a given source at a given point in three-dimensional space.

It should be emphasized that in a municipal region it is completely inadequate to consider only the contribution from the individual source at short range. The effect of the individual contribution must be added to the prevailing background of the contaminant considered over the entire area which will be influenced. It has been shown that very large sources of pollutants can affect air quality at distances exceeding 30 miles from the source. Under particular conditions a multitude of smaller sources can have similar effects.

Application of the diffusion equations inherently assumes that the point of emission is reasonably sited and flow patterns at the point of emission are not significantly influenced by building structures nor by building orientation. In the design of new complexes or in the modification of existing complexes these design aspects must be considered by architects and engineers. There is the additional factor that the emission mechanism, specifically the stack or chimney, should be designed to carry the emissions as high as possible into the atmosphere to permit maximum time for plume dispersion before receptor levels are reached. In the plume rise equations two distinct mechanisms contributing to the total rise are usually included, momentum (or upward velocity at the point of emission) and buoyancy. For many plumes the buoyancy forces are dominant, so much so that occasionally momentum forces are neglected in some plume rise models. Physically, and theoretically, neglect of the momentum term is unrealistic and the emission characteristics and velocity must be considered at the design stages. Exit velocity should be considered in relation to the quantity of discharge and for stacks in excess of three feet in diameter exit velocities greater than 60 feet per second are recommended. For heating plants or for large stacks which handle the discharge from several processes or sources these velocities may be difficult to achieve under reduced load conditions. This has led to the recent development of stacks with multiple flues to handle varying discharge volumes. Such stacks are presently being considered in Ontario. Near lake shorelines or in river valleys it goes almost without saying that the height of the stack itself must be such that we take advantage of the local flow patterns. Such considerations have lead to the design of stacks in excess of 1,000 feet high in Europe and the United States. Finally, in certain instances, it may be necessary to provide process control in certain industries in response to the ability of the atmosphere to disperse the contaminants emitted -- for example -- under special meteorological conditions which result in a temporary build-up of contaminants, viz. low wind speeds and inversions, through-put of industrial processes in the community may have to be reduced during the period that adverse conditions persist.

In summary, we have taken the positive view in this discussion and emphasized those things we must do to maintain, or improve, the existing air quality in our municipalities. This may suggest we are well along the road and can push the "clean air button" tomorrow. This is simply not the case. From initiation of a project to improve our air quality through the design, construction and operation phases may take several years for large undertakings. Furthermore, there are a multitude of problems remaining, particularly with gaseous pollutants, and it will require the co-operation of every single individual to provide effective and continuing control. Continuing research at all levels of air quality control is essential. Air pollution will not simply blow away.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"VEHICLE EMISSION CONTROLS"

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When Mr. Voege invited me to speak here today, he told me that it was the purpose of this conference to "let the public know what is happening with respect to pollution, the progress so far in control, and the state of knowledge regarding it." Furthermore, he stated that the program would be devoted to general, wide, non-technical coverage of the problems, control measures and overall effects of such pollution. This is rather a broad assignment when it comes to motor vehicle emissions, but I will attempt to cover -- in the twenty minutes available to me -- the general nature of the problem, and its control. This will include the type of contaminants discharged and where they come from, covering both the gasoline and diesel engine, the effects of these emissions, the nature of the problems that they cause, standards for the control of emissions, laws relating to this matter and the devices or systems which are now in use for control of emissions and their maintenance.

Most gasoline engines powering motor vehicles today are of a four-cycle type. These four-cycle engines work in the following way: on the downstroke a mixture of gasoline and air is drawn into the cylinders through an inlet valve. This mixture is compressed in the next cycle by the upward movement of the piston. When the air-fuel mixture is compressed, the mixture is ignited by a spark and the explosion drives the piston down and provides power to the vehicle. On the fourth and final stroke, the exhaust port in the cylinder opens and the upward movement of the piston forces the exploded gases through a valve and into the exhaust manifold, from where they are conducted through the muffler and out the tailpipe.

In order to make such a four-cycle engine operate properly, there must be an excess of fuel in the air-fuel mixture. This excess fuel creates two basic problems:

1. On the compression stroke just prior to ignition, some of the air-fuel mixture is forced around the piston rings and into the crankcase. Such gases are commonly referred to as blow-by.

2. Since we have a fuel-air mixture which is rich in fuel, there is not enough air present after ignition so that the fuel can burn to completion. Some of the fuel present in the mixture does not burn at all; some of it burns partially and some burns completely, so that when the gases are exhausted through the exhaust port and out of the tailpipe of the vehicle, they contain large quantities of unburned or partially-burned hydrocarbons and carbon monoxide. If it were possible to burn these fuels completely, the contaminants going out of the tailpipe would be primarily carbon dioxide and water.

There are two other problems of importance so far as emissions are concerned:

1. The high temperatures present in the cylinder after ignition oxidize some atmospheric nitrogen and create oxides of nitrogen.

2. Most gasolines contain tetraethyl lead to prevent pre-ignition. This lead in the gasoline is also discharged to the atmosphere.

Lead and nitrogen oxides would be exhausted to the atmosphere even if we did have perfect combustion.

Gasoline is volatile and some hydrocarbons are lost to the atmosphere by evaporation. This occurs particularly when the ignition of a warm engine is turned off and the fuel in the carburetor evaporates. This is commonly referred to as "hot soak". Gasoline evaporates directly from the fuel tank also and furthermore, vapors are forced from the fuel tank each time the gasoline tank is filled.

What amount of contaminants can come from where? Let's consider the hydrocarbons first. If we take an average vehicle, in the order of 65 per cent of the hydrocarbons are discharged to the atmosphere from the exhaust; about 25 per cent of the hydrocarbons are discharged from the crankcase and about 5 to 10 per cent enter the atmosphere because of evaporation losses. These percentages can vary widely in the individual vehicles and I cite them only to give you an order of magnitude.

Carbon monoxide is a different story. Remember, carbon monoxide is formed only after ignition. As a result, about 90 per cent of the carbon monoxide is discharged from the exhaust pipe and perhaps about 10 per cent from the crankcase. Again, because nitrogen oxides are formed after ignition, about 95 per cent of the nitrogen oxides are discharged through the tailpipe.

Most diesel engines operate on the two-cycle principle rather than the four-cycle. Air is compressed to such an extent that the temperature in the cylinder rises to the point where, if fuel is injected, the fuel will ignite. Diesel engines do not use a spark to ignite the fuel. Without going into much detail as to the differences between a two-cycle and a four-cycle diesel engine, I think it is sufficient to say that the air is compressed first and then the fuel is jetted into the cylinder. There is no compression of an air-fuel mixture prior to ignition. Furthermore, the fuel in a diesel engine burns in the presence of excess air rather than insufficient air. Because there is excess air, hydrocarbons are burned more fully and there is very little carbon monoxide produced. Because the fuel air mixture is not compressed, there are very little hydrocarbons emitted from the crankcase.

Nitrogen oxides are formed in diesel engines as well as in gasoline engines because of the high temperatures involved. Furthermore, some contaminants which are odorous in extremely small concentrations, are formed in the diesel engine and these are the chief complaint that people have about the diesel engine. Unfortunately, the technology for controlling the odors is not yet here.

Smoke is formed in diesel engine operations. Generally speaking, however, the smoke is controllable, since it results from leaky or improperly adjusted fuel jets, from poor operation, or the use of the wrong fuel.

In comparison with the total amount of contaminants discharged from all gasoline engines, the total amount of contaminants discharged from diesel engines is a small part of the total motor vehicle pollution problem. However, because of the odors and smoke discharged, this is a problem about which the public complains most. On a total weight basis, the diesel engines probably account for less than 5 per cent of the total emissions from motor vehicles.

I have heard many people say that motor vehicles are the most important problem we have today in air pollution. If this assessment is based on the total

quantity of contaminants discharged from the total motor vehicle population, they are probably correct. However, this type of assessment does not take into consideration the relative toxicity of the contaminants discharged. For instance, in the order of 150 to 300 times as much carbon monoxide could be discharged to the atmosphere as sulphur dioxide before an adverse effect would be created.

This leads me to the next topic. What are some of the effects of the contaminants which are discharged from motor vehicles?

Carbon monoxide is important because of its potential effect on health. You all probably know that the hemoglobin in the blood normally picks up the oxygen from the lungs and delivers this to the various body tissues. Hemoglobin has a greater affinity for carbon monoxide than it does for oxygen, so when carbon monoxide is present in the lungs the hemoglobin picks up the carbon monoxide rather than the oxygen and forms a product called carboxy hemoglobin. Because of this, less oxygen can be carried to the tissues. If enough carbon monoxide is present, of course, death can result because the blood then cannot carry enough oxygen to the tissues. In lesser quantities, carbon monoxide causes headaches and malaise, a general feeling of not wanting to do anything. Also, it reduces the ability of the individual to discriminate; the individual becomes unco-ordinated; he doesn't react. Of course, as many of you know, it has often postulated that many of the single car accidents are caused by excess exposure to carbon monoxide in the passenger compartments of vehicles. There is some indication that carbon monoxide can cause permanent brain damage, but enough information is not available as yet on this.

Lead in the atmosphere is a different proposition. This also enters the body through the lungs. It gets into the bloodstream and various body tissues; it affects the central nervous system and can cause a disease called lead poisoning. Many people in our urban centers today have high lead body burdens. While these are generally below critical levels, just about all of this results from motor vehicle emissions. Furthermore, lead levels in fruits, grasses and crops grown in the vicinity of highways are above those levels found in remote areas, and this lead finds its way into the population's diet.

Any high temperature such as experienced in the motor vehicle's engine oxidizes the nitrogen in the air to form nitrogen oxides. When these oxides are discharged into the atmosphere, the energy of the sun speeds their reaction with the hydrocarbons, changing nitric oxide into nitrogen dioxide which is five times as toxic to the human as nitric oxide. Worse yet, 95 per cent or more of the nitrogen oxides that are inhaled, remain in the body where they can produce cell mutations and changes in human tissues such as making the lung passages leathery and brittle. It is postulated that this may lead to lung cancer and emphysema. Furthermore, it has been demonstrated that plant growth is suppressed by continuous exposure to low concentrations of nitrogen dioxide, and leaf injury can occur at fairly low concentrations.

Hydrocarbons, in and of themselves, can be a dangerous threat to humans when present in high enough concentrations. However, their chief importance is the part they play in the production of photochemical smog. When hydrocarbons and nitrogen oxides are present in the atmosphere in the presence of sunlight, a very complex reaction takes place. Ozone and a product, peroxy acyl nitrate, which I shall call PAN, is formed. This first slide is indicative of the type of reaction which occurs (slide). PAN, in very minute quantities in the atmosphere,

can seriously damage crops, cause tearing of the eyes and irritation of the mucous membranes. This is typical of the Los Angeles-type smog.

Ozone, a powerful oxidant, can also seriously damage crops. It causes nose and throat irritations, chest pains, coughing, shortness of breath, and nausea. It has been singled out as an important cause of rubber cracking.

There is a small quantity of carcinogens (cancer-producing substances) present in the atmosphere resulting from the partial burning of hydrocarbons. Just what part these play in the increasing cancer incidence, particularly of the lung, is as yet an unanswered question; but the fact is that they are in the air.

Studies have shown that air pollutants can team up to injure plants and people. Combination of contaminants in the atmosphere can cause more injury than any single pollutant alone. For example, amounts of ozone and sulphur dioxide that are separately harmless will damage such crops as grapes, citrus fruits, tobacco and spinach when in combination. Auto exhausts emit little sulphur dioxide; yet sulphur oxides are present from other sources such as fuel burning, and the effects of these combinations of contaminants cannot be ignored.

Two kinds of problems exist in urban areas today resulting from motor vehicle emissions. I was going to say separate and distinct, but I am not too sure as to whether they are or not. One is the type of problem experienced in some of the West Coast cities of the United States, principally Los Angeles and San Francisco, referred to as photochemical smog. This is experienced in those areas having sunlight of high intensity and long duration. As I said before, this smog results from the reaction which occurs after the contaminants get into the air.

The other type of problem is that experienced in other major urban areas -- the New York Metropolitan area, for instance. Here we have a problem which results from the presence of the individual contaminants. But at times, when sunlight intensity is high, we can have the L.A. type smog present too. In the first type of problem, hydrocarbon is probably the most important contaminant to control. In the second type of problem, carbon monoxide is generally the contaminant of prime concern. But perhaps I am getting a little too theoretical at this point, because the controls that we have today and about which I am going to speak later control both the hydrocarbons and carbon monoxide. This, however, was an important consideration in the days prior to the development of exhaust controls.

Now a few words about legislation and regulation.

The State of California has done more than any other governmental agency in studying and regulating the motor vehicle emission problem. Until just recently, New York was the only other state in the United States that had regulations controlling motor vehicle emissions. Since June 30, 1963, no vehicle could be sold in New York State unless it was equipped with a crankcase ventilation system of a type approved by the State Air Pollution Control Board.

The passage of a law is a simple matter; its administration may not be. Criteria have to be developed and various types of systems have to be reviewed.

The same device or system will not work on every vehicle. Each system has to be engineered for a specific engine. Literally, hundreds of different types of crankcase ventilation systems were approved in New York since the state law was enacted.

Exhaust controls were not required on vehicles in 1963 for the simple reason that technology had not advanced to the point where a practical and reasonable system or device could be produced to control exhaust emissions.

Beginning with the 1967 models, the State of California has required exhaust control systems on vehicles, and the same requirement is now in effect in New York State beginning with the 1968 models. The State of New Jersey has a similar requirement.

In 1965, the Federal Air Pollution Law was amended, which required the Secretary of Health, Education and Welfare to establish criteria for new motor vehicle emission controls.

Our federal law is again being amended and the amendment has already passed the Senate and House of Representatives. This law will preempt the rights of the states, exclusive of California, to establish standards for emission controls on new vehicles.

The amended federal law when it passes, will put New York and other states out of the business of approving systems or devices for new vehicles; but it will still leave to each of the individual states the responsibility for inspecting vehicles once they are on the road; and this brings me to the next type of legislation.

The emission control systems that have been developed so far will not work forever. They require inspection if they are to work as they are intended to work. In New York State, our law was amended so that, effective this year, vehicles will have to be inspected at annual intervals, not only for safety purposes but also for emission control systems; and this has created quite a headache because, frankly, the exhaust systems that are on the vehicles this year almost defy inspection in a reasonable and practical manner. To do a complete job of inspecting a vehicle requires somewhere in the order of $30,000 worth of equipment and more than a half-hour's work. We have about 10,800 inspection stations in New York, and to make such an inspection would be extremely impractical. We will have to devise shortcuts and compromises and hope that what we will be doing on the inspection program will be effective in most cases. Furthermore, the sampling of emissions from the individual car means nothing, since the original approvals are based on emissions from a fleet of vehicles.

Now what, specifically, are these systems about which we are talking? Let's first talk about the crankcase ventilation systems. These can be broken down into three different types:

1. The open type system,
2. The closed type system, and
3. The sealed system.

In the open type system (slide), vapors are drawn from the crankcase through the tubing to the flow control valve. This valve meters the flow to suit

the engine operation and returns the vapors into the intake manifold or air cleaners. If the valve is controlled by manifold vacuum, fumes go into the intake and the engine breather is unrestricted. But if the crankcase vacuum controls the valve, fumes sometimes go into the air cleaner. Then the breather is restricted to the amount of air entering the crankcase.

In the closed type system (slide), when the engine manifold vacuum is high, the air flows from the air cleaner through a hose to the rocker cover. The fumes are drawn from the crankcase through an orifice or flow control valve and into the carburetor or the intake manifold. When manifold vacuum is low, fumes are drawn from the crankcase through the line and into the air cleaner and also from the crankcase through the valve and into the manifold. Flow can go both ways in the line. There is no breather used with this system.

In the sealed system (slide) the simplest demonstration is the crankcase to air filter tube. Fumes are drawn from the crankcase to the air cleaner. Fuel-rich fumes fed into the carburetor cause rich mixtures; so if this system gets clogged, it tends to lean out the carburetor mixture. A good feature of this system is that the crankcase fumes that are to be reburned get filtered before they reach the engine. A bad feature is that this tends to dirty the air cleaner.

There are two basic types of exhaust emission control systems:

1. Exhaust air injection and
2. The engine modification system.

The exhaust air injection system (slide) is composed of the following major parts:

a. Air pump,
b. Air distribution manifolds with check valves,
c. Cylinder heads with air injection tubes,
d. Exhaust backfire suppressor valve, and
e. For some engines, revised distributors and carburetors.

The air inlet manifold distributes fresh air from the air pump to the individual exhaust ports in the cylinder head. The cylinder head with air injection tubes provides for the introduction of the air into the exhaust port near the exhaust valve seat. This location most efficiently mixes the exhaust gas and the air for effective burning.

The engine modification system (slide), is composed of the following major parts:

a. A modified carburetor,
b. A slightly altered distributor, and
c. A sensing valve which controls the spark adjustment during deceleration.

In the engine modification system, the carburetor and distributor have been redesigned and a new component, the vacuum advance control valve, has

been added to cars with manual transmissions. The carburetor is calibrated to provide leaner mixtures at idle and at low speed operation. The distributor is designed to give retarded timing at idle. The vacuum advance control valve, in conjunction with the distributor, provides advance timing during deceleration.

Now there is another kind of exhaust control system which has been talked about frequently, two types of which have been approved in California but which have not yet been put into use and perhaps never will be. This is the afterburner or catalytic combustion unit. These really are units which are designed to burn the hydrocarbons and carbon monoxide directly in the exhaust system prior to discharge to the atmosphere.

While we have not as yet advanced to the point where any agency is requiring evaporation controls, there have been a number of these systems developed and I am sure evaporative controls will be required within the next few years. I will not go into detail describing such systems except to say that those which have been developed to date utilize a hydrocarbon adsorbent (activated charcoal). When the engine is not running, the charcoal adsorbs the vapors from the carburetor and from the gas tank. When the engine is started and begins to run, air is drawn through the adsorbent and into the intake manifold. Basically, the system adsorbs vapors when the engine is not in operation and releases the vapors to the combustion chambers when the engine is in operation.

In conclusion, I would say that, in my opinion, we are advancing rapidly toward the emission-free vehicle. If we do not reach the point where we can control all the emissions, we will certainly advance to the point where emissions of contaminants will be minimal. I hate to forecast what the future will bring because so often new developments prove the predictions to be wrong. As I see it now, however, the electrically-powered vehicle is not the solution to the problem. This development is many years off, with a possible exception of a limited-use vehicle. I think that the four-cycle engine as we know it today is on its way out and that the engine that shows the most promise for the future is the turbine or turbine-electric combination.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"WASTE MANAGEMENT IN METROPOLITAN TORONTO"

MR. ROSS CLARK,
COMMISSIONER OF WORKS,
MUNICIPALITY OF METROPOLITAN TORONTO.

Since the turn of the century, the burgeoning development of most countries in the world has been characterized not only by a rapid increase in total population but also by increases in per capita productivity and in the rate of consumption of goods of all kinds. While the consequences, in terms of health, welfare, and general enjoyment of life, are apparent to all, many of the associated effects upon the natural environment have come to be viewed recently as unacceptable on a long-term basis. The problem related to the disposal of wastes has taken on ever-increasing significance, until it is today one of the major enigmas confronting society.

Throughout the world, realization is growing that it is manifestly impossible to continue present rates of industrial and population expansion, and simultaneously maintain a healthy environment under former methods of handling waste products.

At present, wastes are discarded primarily through discharge into natural waters, into the atmosphere, and by deposit on or below the surface of the ground. On reflection, what other possible destinations are available? For, as Roger Revelle once said, our earth may be likened to a space ship on which man journeys equipped with the systems necessary for his survival and comfort but from which he is unable to discharge anything. Hence, gaseous, liquid, and solid by-products of man's activities must somehow be stowed on board or recycled into the resources from which they derived. Haphazard or half-hearted attempts to conceal used materials somewhere in the ship's stores is the story of man's problem of "pollution".

The problem of pollution is the summation of many problems. It has been and continues to be regarded and attacked as a public health menace of ever-expanding proportions, and much of our limited expertise of how to cope with pollution stems from health research and practice. It is also an economic problem intimately and directly affecting industry, agriculture and urban living. It is a social problem tending, in many instances, to create constraints on the nature of urban and regional development and patterns of land use. It is a resources problem, for most of our waste was, in an earlier stage, a useful resource or material. Most certainly, it has political-institutional-management connotations wherein the limited and diverse nature of our efforts to explore, understand, and direct movement and disposition of wastes is clearly demonstrated in almost every major urban complex.

In some aspects the problem is growing faster than are technical solutions. Projections of growth rates of urban populations when compared with related calculations of per capita generation of our waste products seem to suggest that our current extensive investment and effort for abatement must be increased if we are even to maintain the present problematic levels in and adjacent to our centers of population.

According to some informed sources the dimensions and ramifications of the problems are not well understood even by many of those who have responsibility for dealing with one or another of its aspects.

There are many choices, in the matter of our solid wastes. We can burn, bury, or flush them away; alternatively, they can be moved to more convenient, or less undesirable, dumping points by wheels, pipes, or barges. Grinding, treating and neutralizing are other options. Re-cycling is available, although

this practice is generally receiving less and less encouragement in our present economic systems. Generally, cost plays a paramount part in decisions taken. However, we are not yet in a position to completely assess full costs or to analyze benefits that may exist or arise in another community, or decade. It is only recently that experimentation is beginning to yield data and guidance for better system approaches.

As a result, after 10,000 years or urban living, the only practical methods of solid waste disposal available today for large cities of this continent, consistent with the dictates of the budget, are the sanitary landfill and controlled municipal incineration -- and of these the latter cannot cope with all the waste generated in a community.

Both of these methods have inherent and self-evident problems -- cost, and pollution. Suitable areas for landfilling are scarce in the modern urban complex, thus, sites must be sought further and further away, with a corresponding increase in transport costs. Lack of sufficient data on the aging and decaying processes within the heart of a landfill site and on the leaching processes that may carry pollutants beyond the confines of the site require high expenditures for control features today that may in future be accomplished at a lower cost with expanded knowledge. With incineration the problem of cost is initially more severe, and is further increased by the inclusion of the sophisticated control devices required if air pollution is to be kept at an acceptable level.

Confronted with these difficulties and in the realization that the best solution may be not in isolated action, but in a pooling of knowledge and resources, the regional approach is gaining favor across the globe. This type of approach has been adopted with success in the field of water pollution control and it is logical to conclude that it will offer similar advantages in the handling of solid waste disposal.

<u>United States</u>

In the United States, solid waste disposal costs are estimated at $3 - 4 billion per annum -- some $15 - 20 per capita. Throughout the country, authorities are becoming more and more aware of the gravity of the situation. The regional approach is gaining acceptance, slowly, with more and more urban centres following or developing various schemes -- such as Los Angeles, Detroit and others. At the Federal level, The Solid Waste Disposal Act of October, 1965 indicates recognition of the need for intensified coherent research and planning. The Act appropriates $92.7 million for expenditures during the years 1966 to 1969, the stated purposes of the Legislation being:

1. To initiate and accelerate a national research and development program for new and improved methods of proper and economic solid-waste disposal, including studies directed toward the conservation of natural resources by reducing the amount of waste and unsalvable materials and by recovery and utilization of potential resources in solid wastes; and

2. To provide technical and financial assistance to state and local governments and interstate agencies in the planning, development, and conduct of solid-waste disposal programs.

The emphasis on reduction of waste at source and on re-cycling is noteworthy.

The Congressional findings, as reported in the Act, sum up succinctly the problems of refuse disposal in a large modern industrial nation. Accordingly they are recorded for reference, as 'Appendix A'.

Canada - Ontario

In Canada, concern for our environment is evident at all levels of government and efforts are being made to reduce soil, water and air pollutants. The recent conference convened in Montreal with the theme -- "Resources for Tomorrow" -- is but one example.

In Ontario, increasing emphasis is being placed on the problem of waste management and its ancilliary effects. Our conference, today, attests to expanded interest on the subject.

The Ontario Water Resources Commission, in a number of Resources Surveys, has focused attention on many unsatisfactory open dumps because of their contaminating effects on ground and surface waters.

The Ontario Department of Health has established a Waste Management Section in its Environmental Health Branch and, recently, legislation was established permitting enactment of regulations controlling the disposal of solid wastes.

The City Engineers Association of the Province of Ontario have become concerned in respect to the handling of wastes and a copy of their Resolution (December, 1964) in this connection is recorded as 'Appendix B'.

Conservation Authorities become directly involved with many disposal fields in their jurisdictional watersheds and are assuming obligations to assist in the development of rational solutions.

The Conservation Authorities Act permits the adoption of regulations controlling the placing and dumping of fill and consequently, through legislation, authorities are enabled to control filling in river valleys, and specify conduct of the work.

In particular, the Metropolitan Toronto and Region Conservation Authority has been deeply involved in solid waste disposal. The Authority has co-operated with its member municipalities on a number of occasions in providing areas for waste acceptance and has been instrumental in new and improved techniques being developed.

General Methods Employed

A variety of methods are currently practiced for waste disposal in Ontario.

The open dump, appears to be the most common method of waste disposal at present. However the attendent health and contamination problems are rapidly becoming unacceptable to our modern society and it is not unreasonable to assume that this practice will be gradually phased out.

Open fires -- particularly in rural areas for disposal of brush, weeds, etc. -- effective procedures can be followed reducing possible smoke and nuisance.

The sanitary landfill is a relatively recent innovation and has been widely adopted throughout Canada, and across the globe. A continuing pattern of improvement in techniques is playing a part in placing this method high on the acceptance list.

Municipal incineration has been utilized in many waste disposal systems, particularly in large, densely-populated areas.

On-site apartment incineration is widely practiced at present in many large urban complexes, and improvements have been made both in equipment and operation. Nevertheless some cities are passing legislation prohibiting its use, allegedly because of resultant nuisance and air pollution difficulties.

Lakeshore filling has some attraction for communities on the shores of the lakes. Low marshy areas have, on occasion, been filled to create additional parklands or industrial properties. However, with increasing attention being given to water quality in the Great Lakes, and with intensified use of the Lakes for domestic water supply, it is doubtful that this method of waste disposal will be considered as a major solution to the problem. The Ontario Water Resources Commission has indicated the possible pollution hazards inherent in lakefills and does not encourage their establishment. Any project of this nature would require all possible pollution sources to be explored and provision made for their control before approval was gained.

Methods of lesser impact, which have failed to win complete acceptance, include:

> Composting, on a large scale, has not proven to be economically sound up to the present, since current agricultural techniques seem to rely almost exclusively on inexpensive balanced inorganic fertilizers. As a result, there is little or no market for the more expensive compost. In the handling of certain specialized industrial wastes of organic origin, some success has been evident.
>
> Salvage and reclamation is theoretically attractive as an example of the re-cycling process. Unfortunately, as in the United States, the present economy in Canada does not encourage salvage operations, the market for the salvaged product being extremely limited -- and the money gained from sales being below sorting and salvaging costs.
>
> Bulk grinding of food wastes for discharge to the sanitary system is practiced on occasion, and in some cases tends to increase problems in other quarters, i.e. at the sewage plants.

Metropolitan Toronto

The situation currently obtaining in Metropolitan Toronto is a particularization of the general situation outlined. For clarity, a brief survey of the administrative format may be of value.

Metropolitan Toronto was constituted in 1953 by the Province of Ontario and is today a federation of six area municipalities embracing 240 square miles and 1,850,000 inhabitants. At its formation in 1953 -- at which time the number of member municipalities was thirteen -- the Metropolitan Government was charged with defined responsibility for certain major services throughout the whole area. These did NOT include the collection and disposal of refuse, which remained under the jurisdiction of the federated municipalities and of the private industries.

In 1956, further civic functions were integrated as Metropolitan responsibilities, but collection and disposal of refuse were not included.

In 1963, a Royal Commission was established to make general recommendations on the future of Metropolitan Toronto as a whole. The ensuing report, presented to the Ontario Legislature in 1966, suggested unification of refuse disposal within the Metropolitan Area -- (which henceforth was to consist of the six expanded municipalities occupying the same geographic area as the original thirteen).

Arising out of the foregoing, on January 1, 1967, Metropolitan Council assumed complete responsibility for the disposal of all refuse generated within the Metropolitan region. New legislation granted certain powers for the acquisition of lands, subject to requisite approvals, within the Metropolitan Planning Area -- for the purpose of receiving, dumping and disposing of wastes.

The collection of refuse remained the duty of the six member municipalities.

Although the responsibility was new, the function proper was no stranger to Metropolitan Toronto. Refuse disposal within the area had been a matter of grave concern at all levels for over a decade, and had been discussed at length by many authorities -- the original 13 municipalities -- Metropolitan Toronto itself, and the Provincial Administration. At the latter level, several departments and bodies were involves -- including the Department of Health, the Region Conservation Authority, and the Ontario Water Resources Commission.

At the Metropolitan level, the subject was first reviewed in 1956, as an exercise in forward-thinking designed to be of possible future benefit. The ensuing inter-departmental report prepared by the Metropolitan Planning Board and the Department of Works analyzed existing incinerator and landfill facilities and outlined a regional proposal in very general terms. The acute shortage of dumping grounds was stressed. However, coherent action on a regional basis was virtually unattainable in those years, since the responsibility remained vested in the area municipalities.

However, some valuable knowledge was gained when Metropolitan assistance was sought, in 1956, by certain municipalities and industries who were

finding the task increasingly difficult. A special amendment of the Metropolitan Toronto Act empowered the Corporation to render assistance in the matter of disposal (though overall responsibility for the service still remained vested in the area municipalities).

In the ensuing "Operation Overload" -- 1956-1965 -- the Corporation operated some dozen disposal sites on an ad hoc basis, and buried over 3 million tons of wastes on behalf of the area municipalities and private industries. A suitable fee was charged for each load dumped, so that the operation was self-supporting. This assistance had to be terminated in mid-1965, when further sites became unavailable. During this period the municipalities continued to operate their incinerators and landfill properties.

Consultant's Study

Cognizant of impending changes in the waste handling situation Metropolitan Council engaged consultants in March, 1966, to formulate a plan covering the accommodation of waste within the Metropolitan Planning Area for the period 1966-1986. (The Metropolitan Planning Area embraces the Metropolitan Toronto Area of 240 square miles, and each of the fringe municipalities around the boundaries of Metropolitan Toronto, thus exemplifying the regional concept.) The recommendation to Council concerning the assignment forms 'Appendix C' to this treatise.

The Consultants initially assessed the magnitude of the problem, both currently and over the 20-year period to 1986. The salient statistics that emerged from their assessment are included as 'Appendix D': briefly, they forecast a doubling of the load, from 1,645,000 tons of refuse in 1966, to 3,111,400 tons in 1986.

An annual (1966) volume of liquid industrial waste was also ascertained:

Inflammable liquids	- 4,000,000 gal.
Acidic wastes	- 6,041,000 gal.
Alkaline wastes	- 7,656,000 gal.
Inert solutions	- 600,000 gal.

Next, the Consultants conducted a detailed review of the existing facilities that would be available to the Corporation on January 1, 1967 when the service was to be assumed. These facilities were deemed inadequate. They consisted of minor landfill sites within the individual area municipalities, none having a life expectancy beyond approximately October, 1967. There were also seven municipal incinerators with a total rated capacity of 430,700 tons per year, with an eighth under construction capable of handling 85,000 tons/year. However, a significant percentage of the existing capacity was old and outdated. Opinion was expressed that considerable expense would be essential in the provision of adequate air pollution control devices, if it were decided to continue using the existing incinerators in any long-term plan.

Examination in depth of all possible disposal methods applicable to a large program included:

Sanitary landfills	Incinerators
Composting	Lakefront filling
Salvaging	

and for liquid wastes:

Neutralization　　　　Pumping to depth

In summary, sanitary landfills and/or incineration were the only practicable solutions deemed feasible for the bulk of the solid wastes -- though building rubble and inert material might render assistance in certain major construction projects, such as harbor reclamation. A neutralization plan was considered appropriate for liquid wastes.

With this basic hypothesis established, thirteen different combinations of the joint landfill/incineration approach were examined, with specific reference to precise criteria including:

1. Ultimate overall cost to Metropolitan Toronto;

2. Equalization as far as possible of cost per ton disposed, to each of the six municipalities;

3. Availability and cost of landfill sites;

4. Usefulness of existing incinerators, having regard to location and necessary cost of renovation and air pollution devices;

5. Capital cost of new incinerators; and

6. Traffic patterns.

In the examination of possible landfill sites, special studies were conducted on:

1. Direct haul by collecting vehicles;

2. Transporation of refuse by rail;

3. Transportation of refuse by large trucks;

4. Utilization of transfer stations.

This research revealed that transfer stations offered the most economical approach, at an annual saving approximating $1,000,000 in operating costs.

In the examination of incineration, it was established that the cost of rehabilitating and enlarging 5 of the 7 existing incinerators would be greater than that of building new facilities. This led to the second basic hypothesis -- that the ultimate scheme should retain only 2 of the existing incinerators, plus the 1 under construction.

Consultants' Recommendation

In their formal report, the Consultants outline three of the original thirteen schemes that might be considered for ultimate adoption, namely:

Plan I	3 existing incinerators Large new landfill sites 6 transfer stations
Plan II	3 existing incinerators 1 new incinerator Large new landfill sites 4 transfer stations
Plan III	3 existing incinerators 3 new incinerators New landfill sites 2 transfer stations

The Consultants have officially recommended Plan I to the Metropolitan Administration, i.e. modernization of 2 existing incinerators, completion of the third now under construction, the acquisition of large landfill sites mainly outside the Metropolitan Area proper, and the establishment of 6 transfer stations.

Capital expenditure in the next 5 to 7 years is estimated at $40,000,000.

Annual operating costs for Plan I will rise from $8,100,000 today to an estimated $12,000,000 in 1986.

The Consultants, mindful of difficulties inherent in the acquisition of land in other municipalities for refuse disposal purposes, have also formally notified the Municipality that a final choice of Plan should be made by June, 1968.

Special Features

1. Regional disposal facilities will be developed ultimately for domestic, commercial, industrial and liquid wastes.

2. Predominantly, incineration and major landfills will be employed.

3. Incinerators will be equipped with optimum air cleaning devices.

4. Landfills will receive meticulous attention in respect to control of possible water pollution.

5. A small technical research group will be utilized to expand knowledge and operation capabilities on the waste disposal function .. that is, new methods, expansion of salvage, etc.

6. A Technical Committee, composed of senior members from each of the Area Municipalities, will advise in respect to development of the ultimate plan in each detail and phase.

7. Transfer stations will be valuable assets in the plan.

Future

Implementation of the co-ordinated plan for Metropolitan Toronto cannot be effected overnight. Approval has been sought for the expenditure of $30,000,000 over the next four years on the provision of the recommended long-term facilities, but until these are brought into operation, the situation within the Municipality must be regarded as 'critical', due to the inadequacy of the existing short-term facilities. Fortunately, it is recognized as a temporary condition.

Of the seven existing incinerators, those that can effectively be so operated have been placed on a twenty-four-hour-day, seven-day-week schedule. Construction continues on one new incinerator forming part of the long-term facilities, but prolonged labor disputes have unfortunately delayed the work. Thus no relief from this source can be anticipated until late Spring of 1968.

The Corporation is moving to acquire the lands necessary to give effect to the recommendations of the Consultants' Report. One large site of 200 acres has already been obtained within the Metropolitan boundaries in the Eastern Section. Pending the acquisition of further sites, temporary ad hoc transfer stations have been established to permit use of this site more extensively than will apply in the final scheme. No palliative is being overlooked -- for example, individual municipalities are co-operating by the establishment of small sanitary landfill sites with attractive end-uses such as ski hills.

The experience that we in Metropolitan Toronto have already gained emboldens us to make some generalizations about the future disposal practices. Firstly, it would seem axiomatic that research must be carried out, and broadened, on a continuing basis. Unquestionably, there is a serious and pervading need for knowledge -- for precise, reliable data that can be utilized for specifying system design, performance and management.

In this field, there would seem also to be a need for a more general dissemination of the results of research. The expert knowledge which is to be found in universities, major government agencies, and the headquarters' staffs of large corporations often does not filter through to smaller agencies and to the industrial field structure. Clearly, action in this sphere must be initiated at the government level.

Secondly, we envisage the need for establishment of standards -- standards of acceptability in respect of air emissions from municipal incinerators, standards of operation and design for sanitary landfills, and the like. A greater public awareness of the problem and its implications is gradually coming forward. The degree of cleanliness of a community's environment is a matter for decision. Cleaning up costs money. What price are we willing to pay? Pollution cannot be completely eliminated; thus definition of tolerable and acceptable limits is considered a matter of urgency. The right amount of pollution must be planned, with criteria set somewhere between the ideal of complete cleanliness and the havoc of uncontrolled filth.

Thirdly, the magnitude of the problem would seem to demand that every new approach, however unorthodox, should be most thoroughly investigated. Existing techniques must be re-examined with a view to intensification leading to new uses. Here, an example might be the new Japanese baling process, which produces solid cubes of compacted refuse enclosed in plastic or metal sheathing,

with the possibility of permanent storage. The deliberate "borrowing" of the sanitary sewage trunk mains for the transport of ground refuse from one point to another at a cost cheaper than that of conventional wheeled transport is another such example.

The exotic techniques of the future must not automatically be laughed out of court as "science-fiction". For example, the destructive powers of the laser beam are already known and application of these powers in the field of refuse disposal might become valuable. Perhaps the arcane science of nuclear physics will offer a promising avenue of exploration?

Current administrative practices should be looked at with a more imaginative eye. The "bulk garbage train", for example, is by no means a new thought. In theory, it would seem to offer many advantages, and the American Public Works Association and New York Central Railway are presently undertaking a $500,000 research study. There is perhaps merit in a suggestion that several large municipalities many miles apart should join together in the operation of one vast 10,000-acre sanitary landfill park far removed, and served by bulk trains shuttling to and fron on computerized schedules that would reduce the cost to each participating municipality.

Perhaps, in the final analysis, the solution to the problem may be found in the two-pronged conservational approach advocated by the United States Solid Waste Disposal Act of 1965, in which enlightened public thinking will accept -- and even demand --

1. A diminution at source of today's ever-increasing flow of refuse,

2. The second prong being represented by the re-cycling and reclamation processes which are today regarded predominantly as an unacceptable and time-wasting expense.

An apt closing sentence may be taken from the National Academy of Science's Report of 1966 on Waste Management and control:

> "There are no <u>consumers</u> -- only <u>users</u>. The user employs the product, sometimes changes it in form, but does not consume it -- he just discards it. Discard creates residues that pollute at an increasing cost to the consumer and to his community. But if we close the loop from user back to resource so as to remake the discards, we approach an ultimate solution."

Or again, from the same source:

> "Even without further research it is quite clear that many of the residue disposal problems can only be met in an ecologically sensible way by elimination of the source and by closed systems."

Mr. F. May, Chairman of the American Can Company, stated to the National Packaging Conference:

> "Pollution control consultants are quite direct about cans, glass bottles, plastic bottles, metal and plastic caps and crowns and paper-

board packaging. They state unequivocally that one of the most difficult problems in waste disposal are these used containers and packages. Convenience packaging, is rapidly becoming problem packaging, and we all are caught right in the middle."

Public Law 89-272
89th Congress, S. 306
October 20, 1965

AN ACT

... to authorize a research and development program with respect to solid-waste disposal, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled.

TITLE II - SOLID WASTE DISPOSAL

Short Title

Sec. 201. This title (hereinafter referred to as "this Act") may be cited as the "Solid Waste Disposal Act".

Findings and Purposes

Sec. 202. (a) The Congress finds -

(1) that the continuing technological progress and improvement in methods of manufacture, packaging, and marketing of consumer products has resulted in an ever-mounting increase, and in a change in the characteristics, of the mass of material discarded by the purchaser of such products;

(2) that the economic and population growth of our Nation, and the improvements in the standard of living enjoyed by our population, have required increased industrial production to meet our needs, and have made necessary the demolition of old buildings, the construction of new buildings, and the provision of highways and other avenues of transportation, which, together with related industrial, commercial, and agricultural operation, have resulted in a rising tide of scrap, discarded, and waste materials;

(3) that the continuing concentration of our population in expanding metropolitan and other urban areas has presented these communities with serious financial, management, intergovernmental, and technical problems in the disposal of solid wastes resulting from the industrial, commercial, domestic, and other activities carried on in such areas;

(4) that inefficient and improper methods of disposal of solid wastes result in scenic blights, create serious hazards to the public health, including pollution of our air and water resources, accident hazards, and increase in rodent and insect vectors of disease, have an adverse effect on land values, create public

nuisances, otherwise interfere with community life and development;

(5) that the failure or inability to salvage and re-use such materials economically results in the unnecessary waste and depletion of our natural resources; and

(6) that while collection and disposal of solid wastes should continue to be primarily the function of State, regional, and local agencies, the problems of waste disposal as set forth above have become a matter national in scope and in concern and necessitate Federal action through financial and technical assistance and leadership in the development, demonstration, and application of new and improved methods and processes to reduce the amount of waste and unsalvageable materials and to provide for proper and economical solid-waste disposal practices.

APPENDIX 'B'

Resolution

City Engineers' Association of the Province of Ontario

"Whereas the disposal of refuse, both household and commercial/industrial is a matter of growing concern and economic cost to the municipalities of the Province.

"And whereas the cheapest method of disposal available at this time appears to be the sanitary landfill, the present economy of which is dependent on the availability and proximity of suitable sites, which in many areas are rapidly disappearing, or where available, their use may be objectionable to conservationists, or may become sources of pollution to water courses or to underground water supplies,

"And whereas, at present, control of landfilling is under several Legislative Acts including the Conservation Authorities Act, Section 20 (1) (e), the Public Health Act, Section 6 (43), the Ontario Water Resources Commission Act, Section 26 (3) and under the jurisdiction of several provincial departments and/or commissions,

"And whereas incineration, which appears to be the next most common method, also needs areas for disposal of residue and requires care to avoid excessive air pollution,

"And whereas disposal of volatile chemical and industrial wastes is not entirely acceptable either in conventional sanitary landfills or incinerators,

"Therefore be it Resolved that the City Engineers Association Advisory Committee to the Ontario Water Resources Commission requests the Commission to institute, or to investigate which provincial agency should institute studies into the long-range methods and economics thereof, for disposal of these types of wastes, as control would be preferable on a regional basis rather than on a limited municipal basis, and an effort should be made to centralize all regulation and control under the jurisdiction of one provincial agency."

A similar resolution was later forwarded by the Association directly to the Premier of Ontario.

APPENDIX 'C'

Report of Commissioner of Works
of March 3, 1966
in Connection with Recommendation
for the Engagement of Consultants

"Disposal of garbage, industrial and demolition materials along with other solid and liquid wastes generated by our society is one of the major problems confronting urban municipalities today.

According to recent surveys, few communities on this continent have developed comprehensive master plans to cope with this environmental enigma over the next few years. The Federal Government in the U.S. recently gave serious attention to the waste problems in that country and the research and planning considered essential.

The Premier of Ontario has indicated that this function will become a Metropolitan Toronto responsibility as of January 1, 1967 pending passage of legislation to implement changes in the Metropolitan structure of government following receipt of the recent Royal Commission report.

While it may appear premature to become involved prior to legislation, the timing of preparatory steps for acceptance of this new responsibility is such that action must be taken immediately. Comprehensive studies of the problem must be carried out, with development of a long-range programme indicating facilities required, the economics, and the acceptability of landfills, incineration, etc. ...

...... We recommend the engagement of Consultants to prepare a full-scale report on the needs within the Metropolitan Toronto Planning Area for refuse disposal; and to make recommendations relative to construction, land acquisition, disposal methods, financing and administration required in connection therewith."

APPENDIX 'D'

Consultants' Report

May, 1967

Statistics and Projections

(Year)	1966	1971	1981	1986
		(expressed in thousands)		
Population in Metro	1,883.2	2,138.1	2,518.2	2,636.0
(following expressed in thousand tons per year)				
Municipally collected refuse	732.1	982.0	1,298.0	1,432.3
Privately collected refuse	386.9	554.2	827.2	928.1
Subtotal	1,119.0	1,536.2	2,125.2	2,360.4
Other Solid Wastes				
Building Rubble & Waste Lumber	58.0	50.0	50.0	50.0
Inert Material	100.0	100.0	100.0	100.0
Trees	38.0	38.0	38.0	38.0
Ash from Power Stations	288.0	362.0	500.0	500.0
Street Sweepings, etc.	50.0	53.0	58.0	60.0
Manure	2.0	2.0	2.0	2.0
Total Quantity of Solid Wastes	1,645.0	2,144.2	2,873.0	3,111.4

Quantities and characteristics of Liquid Wastes are recorded elsewhere in this paper.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"MUNICIPAL WASTE WATER TREATMENT"

MR. A. R. TOWNSHEND, P.Eng., B.A.Sc., M.S.E.,
SUPERVISOR, DESIGN APPROVALS BRANCH,
DIVISION OF SANITARY ENGINEERING,
ONTARIO WATER RESOURCES COMMISSION.

Introduction

The topic of this afternoon's concluding session is "Municipal Waste Water Treatment". Its purpose is to familiarize you with the various methods of municipal waste water treatment and the relative merits of each so that you may better understand the technical problems associated with the implementation of the Province's water pollution control programs.

After answering the basic questions: "What is Sewage?", "What is a Sewerage System?", and "Why Sewage Treatment?", I will then take you through a typical, complete secondary sewage treatment plant showing you with the aid of photography some of the alternative methods and equipment in use today. Our tour will be concluded by a discussion of adequate operation and maintenance. Next, we will consider some of the different biological methods presently available for the treatment of wastes to various degrees of purification. I have prepared two tables and four graphs on treatment efficiencies and costs to help us compare these various treatment methods.

The paper ends with brief statements on effluent polishing of plant effluents and the need for economical, advanced waste treatment methods.

The summary highlights seven of the points made in the paper, which I hope will constitute a meaningful message for you to take back to your respective groups and municipalities.

What is Sewage?

Sewage may be defined as the waste water or used water of the municipality coming from homes, businesses, institutions and industries together with whatever ground water and wet weather runoff as may be mixed with it.

Domestic sewage consists of the liquid wastes from toilets, bathing, clothes' washing and preparation of food.

Industrial wastes are rapidly becoming the most important sources of organic pollution. In some municipalities, the industrial wastes far outweigh the domestic sewage in strength and cause operating problems at the biological treatment plant because of their toxicity and shock-loading effect. Some of the more important industrial wastes are produced by the dairy industries, the chemical industries, the meat processing industries and the textile industries.

The biological oxygen demand (BOD) is a term used to express the strength of sewage. It can be defined as the amount of oxygen required to sustain the aerobic oxidation of the organic solids in the wastes by the aerobic bacteria. A typical raw municipal sewage has a BOD_5 of 200 ppm.

It should be evident from its definition, that the characteristics of sewage vary from one municipality to another. When a municipality undertakes a sewage treatment project, every effort should be made to secure knowledge of the nature, treatability, and quantity of the wastes.

The municipality at the same time should pass a sewer use by-law governing the discharge of industrial wastes to the sanitary sewers to protect its investment, to make possible effective and economical operation, and to control overloading.

What is a Sewerage System?

A sewerage system is a network of pipes, manholes, pumping stations, and forcemains constructed to gather wastes from the municipality and to transport them to a central point for treatment and/or disposal. The network of sewer lines is laid out to take maximum advantage of gravity, and to prevent anaerobic conditions.

A separate sanitary sewerage system should carry only sanitary wastes. With modern pipe and jointing methods, infiltration from ground water can be kept to a minimum. Roof leaders should not be connected to the sanitary sewerage system. In those municipalities where the storm sewer is not deep enough to drain basements, it is common practice to connect the footing drains to the sanitary sewer.

The storm sewerage system should not be connected to either domestic or industrial waste lines. Its purpose is to gather and transport footing drainage, rain water from the streets and from downspouts, and uncontaminated cooling water directly to a receiving stream, without flooding.

Unfortunately, a number of the older communities in the Province have combined sewerage systems; that is, a single system which serves both sanitary and storm needs. The combined sewers are designed to carry the sanitary flow plus the design storm flow. These systems are undesirable because:

1. During non-storm periods, much settling out of organic and inorganic solids takes place. When storms occur, these solids are picked up and mixed with the total flow in the sewer. In most municipalities that have combined systems, it is not economically feasible to carry all of the combined sewage flow to the sewage treatment plant for treatment. Numerous overflows are found throughout the system which will discharge much of the accumulated organic solids from the municipality into the receiving stream.

2. During heavy rains, which exceed the design frequency for the combined sewer, it is not uncommon for basements of homes to flood in many sections. With combined sewers the basements are not only flooded with storm water but with sewage, diluted to be sure, but still sewage.

It is the policy of the Ontario Water Resources Commission not to approve of new combined sewer construction. To prevent the pollution presently occurring from combined sewers requires very costly correction programs for those municipalities concerned.

Why Sewage Treatment?

Waste water treatment works have as their objective, the prevention of damage of many kinds:

1. Contamination of drinking water supplies;
2. Pollution of bathing beaches;
3. Conditions offensive to sight and smell;
4. Infection and destruction of fish and other valuable aquatic life, and;
5. Impairment of natural waters for other beneficial uses.

For Ontario, the policy of the Ontario Water Resources Commission has always been to require such degree of treatment that the effluent will not unduly impair the quality of receiving waters. The adoption of a new policy regarding water quality objectives in June this year has provided a more rational basis for the determination of effluent requirements. It takes advantage of our present technology of stream analysis, while still preserving the beneficial uses of the receiving waters.

Sewage treatment facilities, therefore, are required to suit the particular receiving stream. As the required efficiency of treatment increases so does the complexity of processes resulting in increased capital and operating costs.

There are many processes and many types of equipment for each process available to the design engineer in deciding on the most suitable facility for a particular municipality. It should be recognized that all receive careful study.

The designer needs sufficient time to examine these methods. In so doing, he must give particular attention to the composition and peculiarities of the sewage to be treated. This in turn may required detailed sampling and waste treatability studies prior to final design.

Waste Treatment Methods

The treatment methods presently in use in Ontario remove coarse material, clarify the sewage, stabilize the sewage, and destroy bacteria and other organisms.

Preliminary Treatment

Preliminary treatment devices are used to remove or mascerate the larger material such as paper and rags, to remove the heavy inorganic solids such as grit, and to remove excessive amounts of oils or greases. The commonly used devices in preliminary treatment include screens, comminuting devices, grit removal tanks, flotation units, pre-aeration tanks, and pre-chlorination facilities.

Primary Treatment (Sedimentation)

Primary treatment devices are designed to remove the organic and inorganic settleable solids from the sewage by gravity sedimentation.

In modern sewage treatment plants, the primary settling tanks are equipped with mechanical scraper mechanisms for carrying the collected sludge to pits from where it is pumped to the sludge treatment facilities.

With primary treatment, about 25 per cent of the BOD_5 is removed and about 60 per cent of the suspended solids. These efficiencies may be increased somewhat by the addition of pre-aeration, which conditions solids for improved separation.

Secondary Treatment (Biological)

Secondary treatment is the term applied to biological processes providing a higher efficiency than primary treatment. Secondary treatment processes depend upon aerobic organisms (mainly bacteria) for the biochemical decomposition of organic solids to inorganic or stable organic compounds. The organisms essential to the process require oxygen and treatment proceeds without odor if suitable aerobic conditions are maintained.

The four main types in use for municipal treatment in Ontario are activated sludge, trickling filters, waste stabilization ponds, and aerated lagoons.

Activated Sludge

In Ontario, most sewage treatment systems now being constructed provide secondary treatment utilizing the activated sludge process. It operates on the basis of supplying adequate oxygen to the micro-organisms eating the organic wastes over sufficient time to produce the degree of stabilization desired. A flocculant mass is produced which separates from the water upon quiescent sedimentation. This flocculant material is the activated sludge.

A conventional activated sludge plant will include the pre-treatment and primary treatment facilities already mentioned together with aeration tanks, aeration equipment, final settling tanks, return facilities, and effluent chlorination facilities.

The design of activated sludge systems is based upon the relationship of the BOD_5 loading to the sludge solids under aeration. The conventional activated sludge process uses loadings in the range of 20 to 40 pounds of BOD_5 applied per 100 pounds of mixed liquor suspended solids. This gives a retention time in the aeration tank from five to eight hours depending on the concentration of suspended solids carried in the system.

Today, there are many different modifications of the activated sludge system available, which utilize different loading rates and detention times. The more important of these will be discussed in a later section of the paper.

Trickling Filters

Trickling filters are the old standby in biological waste treatment systems. They are basically beds of rocks with micro-organisms on the

rock surfaces. As it trickles over the microbeal surfaces, the microbes remove the organic matter and with oxygen from the air metabolize the organic matter aerobically. The short liquid contact period prevents trickling filters from being very efficient.

In Ontario, the trickling filter method for municipal treatment has almost been abandoned because of its lower efficiencies during cold weather and operating problems with freezing conditions.

The advantage of the filter, however, is its ability to withstand shock loadings of industrial wastes and wide variations in sewage quality and quantity. Research is going on at the present time to improve the trickling filter process. In the future, we may see its re-introduction, particularly on industrial waste treatment applications using higher application rates and plastic media.

Waste Stabilization Ponds

Waste stabilization ponds are shallow excavations designed and constructed to receive raw or pre-treated domestic sewage and some organic industrial wastes. The purification process is dependent on the combined action of wind, sunlight, temperature, sedimentation, bacteria and algae.

In Ontario, waste stabilization ponds have been favored for the smaller centres, important factors being low operation and maintenance costs. Here, waste stabilization ponds are designed on the basis of one acre per 100 persons or 20 pounds of BOD_5 per acre per day. At this loading, odor difficulties are not experienced and treatment efficiencies nearly equivalent to the conventional activated sludge process are obtained. It is recognized, however, that excessive loadings on stabilization ponds can produce problems with odors, particularly during the spring break-up period.

Aerated Lagoons

Aerated lagoons are a recent development first used to eliminate problems created by overloaded waste stabilization ponds. The continuous oxygen supply of the aeration device permits the aerated lagoon to handle more waste water per day per unit volume.

Aerated ponds with mechanical aerators and detention times of two to four days have given 50 per cent BOD_5 removal. They are usually followed by a conventional stabilization pond for further treatment. This type of aerated lagoon creates dispersed activated sludge which requires several hours for significant sedimentation of solids. To date, the optimum detention time of the conventional pond has not been established.

So far, diffused air designs have used longer detention times resulting in algae growths rather than low level activated sludge.

Aerated lagoons are now being considered instead of/or in conjunction with conventional waste stabilization ponds where BOD_5 loadings are high and land is expensive or unavailable. In the near future, when

optimum detention times are established and equipment perfected for continuous operation in our climate, more elaborate and efficient aerated lagoon systems will likely be developed utilizing activated sludge.

Chlorination

Chlorination is a method of treatment which is employed for many purposes in all stages of sewage treatment. Where chlorination facilities are provided, application points include: pre-chlorination for odor control and to facilitate primary settling, chlorination of return activated sludge, and post-chlorination of the final effluent.

The most widespread use of chlorination at modern sewage treatment plants is for effluent chlorination. Chlorination has long been considered to have the greatest practical potential of all disinfection systems for freeing sewage of pathogens.

The amount of chlorine necessary to obtain a satisfactory reduction of bacteria varies greatly with the kind of treatment the sewage has received. It is not customary to specify a fixed dosage, but rather to require sufficient chlorination to give a specific residual -- example 0.5 ppm -- after 15 minutes contact. This amount of treatment has been found to be adequate in most cases.

Solids Treatment and Disposal

The solids removed from sewage in both primary and secondary treatment units constitute sewage sludge.

In Ontario, most small communities and many in the medium-size group treat sewage sludge by digestion and air drying. Larger communities utilize sludge digestion, vacuum filtration and even incineration. A few communities employ raw sludge vacuum filtration alone. The growing popularity of vacuum filtration at small or medium-size plants reflects improvements in filter equipment and process controls.

Final disposal is often on the land in liquid or dried form as a soil conditioner. Sludge in the form of a cake or ash may be buried in land fill areas.

While sludge digestion, filtration, incineration, sludge drying beds, and truck haulage have proved to be satisfactory methods to date in Ontario, the time may be coming when the more sophisticated and costlier methods will have to be used. These include a number of patented processes utilizing combinations of thickening, drying, vacuum filtration, centrifuging, oxidation, filter pressing, heating and incineration.

Plant Operation

Sewage treatment plants should receive careful operation and maintenance by qualified operators. There must be incentive to efficiency and pride in the work being done. The operators should be encouraged to keep accurate records, to follow a regular equipment maintenance program, and to keep the plant

attractive in appearance by good housekeeping. Finally, they should be provided with a proper laboratory and be instructed to perform the basic control tests.

All too frequently in the past, sewage treatment facilities have been considered necessary evils to be given a minimum of expenditure and supervision. The plants deteriorated quickly, the investment was jeopardized, and the whole works became an eyesore.

At the plants operated by the Ontario Water Resources Commission every effort has been made to show the public that modern well-maintained plants can be clean and attractive. This program is begun when the plants are first placed into operation by means of a public opening followed by an open house and continued over the years by plant tours of school and club groups. Newspaper, radio, and television coverage of these local events helps to give effective publicity to the overall program of showing the public what is being done and how its money is being spent.

Modifications of the Activated Sludge Process

There are a number of modifications to the activated sludge process which are in common use in modern plants today. They have been developed to overcome weakness or difficulties of operation, to allow increased permanent or shock loading, to obtain even better treatment efficiency, and to decrease capital costs. The processes to be considered are extended aeration, oxidation ditch, contact stabilization, and rapid bloc.

Extended Aeration

The extended aeration process is a low loading completely mixed process. By employing 24-hour aeration time and a BOD_5 loading of 10 to 15 pounds per 1000 cubic feet, it is possible to reduce the quantity of excess sludge to a minimum and to maximize the reduction of waste organic matter.

The beauty of the extended aeration system lies in its simplicity of operation. It consists of an aeration tank followed by a gravity settling tank. Sludge is re-cycled from the settling tank to the aeration tank. The excess solids may be discharged in the effluent or wasted to a sludge holding tank. The latter method is used in Ontario to meet the Commission's effluent objective of no more than 15 ppm BOD_5 and suspended solids.

Oxidation Ditch

The oxidation ditch is a special means of carrying out the extended aeration process using a rotor as the aeration and mixing device rather than diffusers or turbine aerators.

Aeration of raw sewage and return sludge is carried out in an open ditch which usually forms a closed oval in plan and is about 4 to 5 feet in depth. The effluent from the oxidation ditch flows to a final settling tank from where the effluent passes to the receiving stream. Sludge from the settling tank is returned to the oxidation ditch.

Contact Stabilization

This is a more complex modification of the conventional activated sludge process based on the fact that the composition of domestic sewage is only 15 to 25 per cent soluble organics to 75 to 85 colloidal and suspended solids.

In the process, raw sewage is mixed in a contact tank with activated sludge from the re-aeration tank to absorb colloidal and suspended solids. To remove the soluble organic matter and to allow for fluctuations in hydraulic flow, the mixing period in full size plants may be as long as 1.5 hours. The volumetric loading for the contact tank is in the order of 70 pounds BOD_5 per 1000 cubic feet of tank. The activated sludge with its adsorbed material then enters the settling compartment. After settling, the sludge is pumped or is returned by air lift to the re-aeration tank. In the re-aeration tank, the micro-organisms convert the sludge to the soluble state. As mentioned previously, the sludge from the re-aeration tank flows into the contact tank to be mixed intimately with the raw sewage. The re-aeration tank is sized to provide a maximum retention time of 6 hours based on the dry weather flow.

Rapid Bloc

One of the high-rate activated sludge processes becoming more popular is the rapid bloc system which operates at relatively high organic loading (125 pounds of BOD_5 per 1000 cubic feet per day). The success of the system depends upon adequate oxygen transfer, good mixing, and rapid sludge return. It has all the operating and efficiency advantages of complete mix design. While requiring smaller aeration tanks, the system produces more excess sludge than the conventional activated sludge process and therefore, requires more sludge treatment facilities. The rapid bloc systems installed in the Province of Quebec use aerobic digestion as a method of sludge treatment.

The rapid bloc system consists of a unitized aeration and final settling tank separated by a dividing wall and baffle. The aeration and settling compartments are inter-connected by means of a continuous sludge "chimney". Raw or settled sewage is uniformly distributed longitudinally throughout the aeration tank. The aerated mixed liquor flows into the final settling compartment through a system of adjustable slots or orifices. The rate of return sludge is adjusted by opening or closing the inlet slots.

Treatment Efficiencies and Effluent Quality

Recognized treatment efficiencies for primary and biological processes are given in Table 1. Treatment efficiencies for the conventional activated sludge process and its modifications are shown in Table 2. These tables also record the effluent quality of the various processes as measured by the BOD_5 and suspended solids tests. The effluent quality figures are averaged actual results and do not necessarily correspond to the respective treatment efficiency values which depend upon varying raw sewage strengths.

Construction Costs

Construction costs for the primary and biological waste treatment plants discussed are given in Graph 1 in 1967 dollars per equivalent population. Equivalent population is the contributing population plus the industrial waste load expressed in population units. Capital costs for the activated sludge process and its modifications are compared in Graph 2.

In all cases, land, engineering and contingencies have been excluded except for waste stabilization ponds where the surface acreage has been included at $350 per acre. Also, the costs for waste stabilization ponds do not include the main sewage pumping station and forcemain usually required for this method of treatment. The curve for contact stabilization plants is for field erected steel tanks rather than for concrete tanks as is the case for the extended aeration and conventional activated sludge plants.

The graphs have been prepared from the estimated costs of the various sewage treatment plants built in Ontario supplemented by costs obtained from other sources for those processes not presently in use in Ontario. The capital cost of a conventional activated sludge treatment plant serving 10,000 equivalent population is in the 50 to 60 dollar per capita range.

Operating Costs

The 1966 operating costs for the primary, conventional, activated sludge, extended aeration, and waste stabilization ponds operated by the Ontario Water Resources Commission are shown in Graph 3.

The annual operating cost of a conventional activated sludge plant serving 10,000 equivalent population is in the range of $2.50 to $3.50 per capita.

Total Annual Costs

The previous cost graphs have shown that the various treatment processes have different construction and operating costs. To compare the total costs, it is necessary to either capitalize the operating costs or convert the capital costs to annual costs.

Graph 4 gives total annual costs for those processes for which the necessary data are available. In preparing the graph, it was assumed that the rate of interest was 6.5 per cent and the number of years over which the capital cost is financed was 30.

The total annual cost of a conventional activated sludge plant serving 10,000 equivalent population is in the range of $7 - $8 per capita.

Effluent Polishing

Effluent polishing facilities have been installed at a number of plants in Ontario at critical locations to protect public water supplies and streams having low or intermittent flows. The methods used or studied to date, include effluent

sand filtration, mechanical filtration, ponding, and micro-straining. The objective of effluent polishing facilities is to reduce the BOD_5 and suspended solids level of secondary treatment plants from the 15 to 30 ppm range down to the 5 to 15 ppm range on a continuous basis.

The Need for Further Treatment

The removal of biologically oxidizable organics may soon be no longer adequate treatment for waste water. There is gradually developing a need for more advanced waste treatment processes to remove nutrients, mineral salts, and remove exotic organic chemicals which are not broken down by the presently used biological systems.

Various treatment methods are now being studied in laboratories and at pilot plants throughout the world. Generally, processes are available with existing technology to do the job, but these techniques are very costly as compared to present treatment methods. It has already been shown that activated sludge systems can be designed and operated to reduce the nitrogen content in the effluent. Phosphorous can be effectively removed by chemical precipitation followed by mixed media filtration. Absorption by activated carbon for removal of organic compounds has been highly effective. Oxygen, ozone, chlorine and chlorine dioxide have been tried as oxidizing agents in waste water treatment. On the whole, however, oxidation methods using oxidants of these types are limited by the selectivity of the oxidation processes.

Summary

1. In answering the question "What is Sewage?", I indicated the need for adequate flow, quality, and even treatability studies so that the design engineer can establish processes which will give maximum treatment at minimum cost.

2. I would now like to remind you of the advantages of separate sanitary and storm sewer systems over combined sewer systems and the need for sewer by-laws to protect the sanitary sewerage system itself and to assure consistently good treatment at equitable cost.

3. I have attempted to familiarize you with the various processes and types of equipment presently in use and available for the treatment of municipal waste waters. By now, you should realize that there is much scope for judgment and a stimulating challenge to consulting engineers, municipal engineers, and sanitary engineers in selecting the combination of treatment processes best suited for a particular municipality. Personal preferences and experience cannot help but enter into the decision-making process.

4. With a minimum of architectural treatment, aesthetic landscaping and good housekeeping, municipal water pollution plants should be and are public buildings to be proud of. Tell your people what you are doing about water pollution control! Let them tour your plant!

5. The tables and graphs have given you some idea of the treatment efficiencies, effluent quality, construction costs, annual costs, and total annual costs of the various processes. These data indicate that a system can be selected to give any degree of treatment desired within the limits of biological processes. Some of these systems are highly competitive and require very close study to select the most economical one to serve a particular municipality. There is no one system which stands out as the most effective and economical for all!

6. In touching on effluent polishing, I presented means of further improving the effluent quality of existing biological treatment systems. This can also be achieved to a considerable extent by adding equalization basins to the flow sheet and/or designing for more than the average daily flow and loading conditions.

7. All of us concerned with water pollution control, whether we be engineers, plant operators, scientists, citizens, municipal officials, equipment manufacturers, or contractors are presently challenged with the task of developing more economical methods of advanced waste water treatment, of sludge treatment, and ultimate sludge disposal.

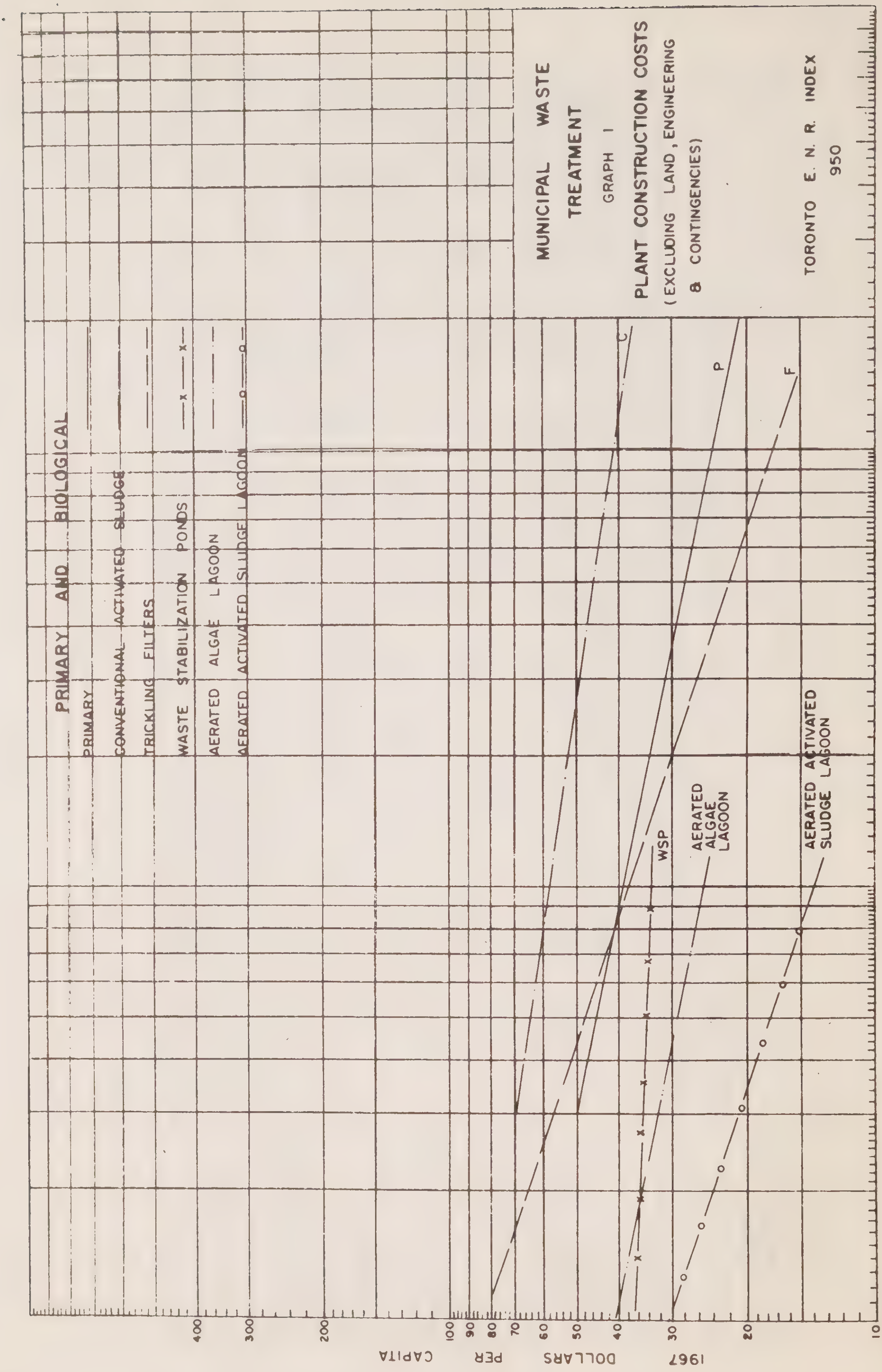
TABLE 1. MUNICIPAL WASTE TREATMENT - PRIMARY AND BIOLOGICAL PROCESSES
PER CENT TREATMENT EFFICIENCIES AND EFFLUENT QUALITY

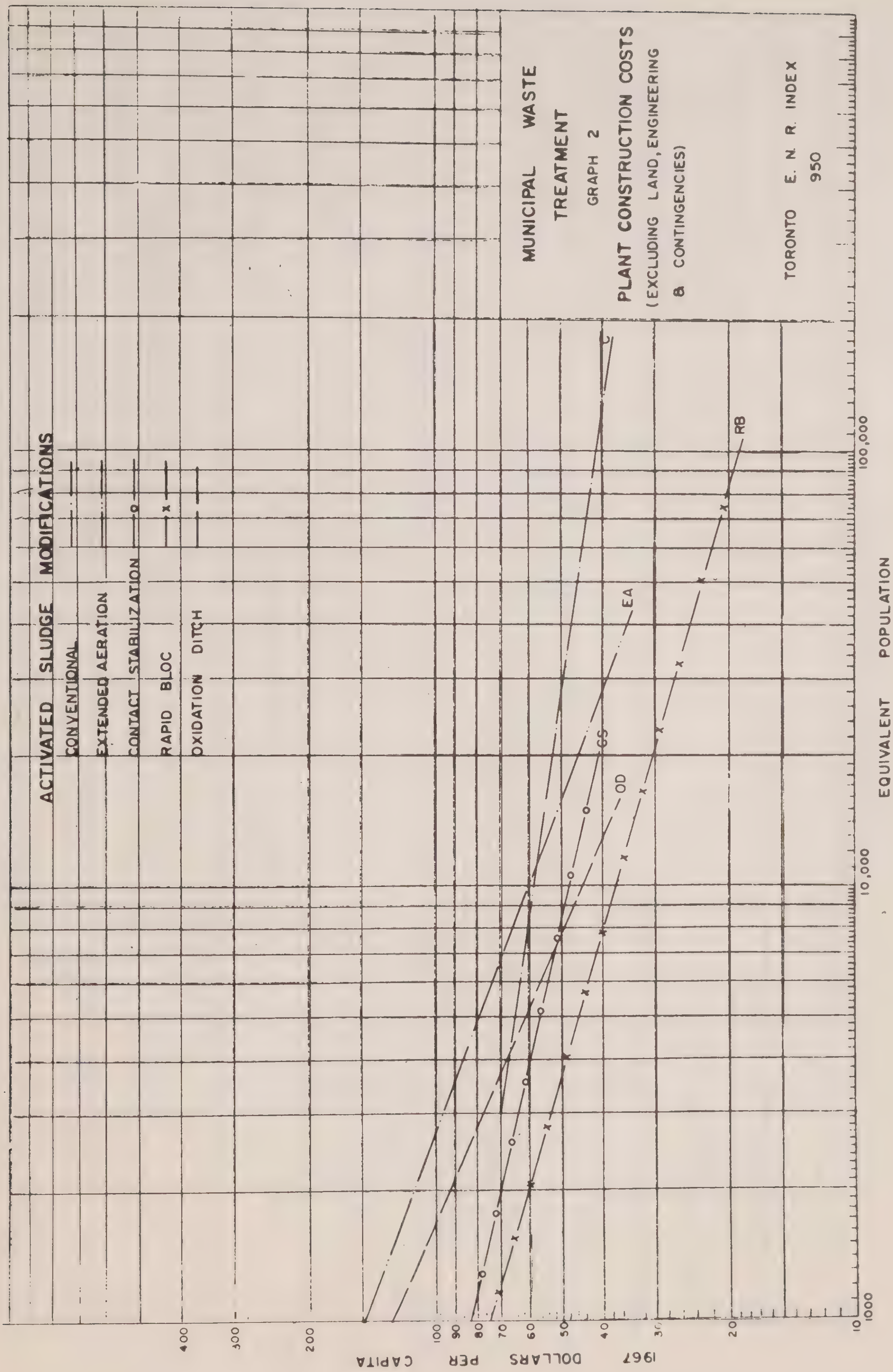
PROCESS	PER CENT EFFICIENCY						EFFLUENT QUALITY - PPM					
(Number of Plants Reporting)	BOD_5			Suspended Solids			BOD_5			Suspended Solids		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Septic Tanks (30)	0	33	50	0	53	68	100	132	200	64	94	200
Primary (20)	15	25	40	40	60	75	28	64	127	29	64	126
Aerated Activated Sludge Lagoons (4)	0	50	60	50	0	0	85	100	390	97	300	650
Trickling Filters (16)	45	75	84	35	72	90	16	34	65	19	38	66
Aerated Algae Lagoons (3)	60	80	90	25	70	85	20	40	110	20	60	175
Waste Stabilization Ponds (40)	80	90	95	65	82	95	7	18	41	9	33	75
Conventional Activated Sludge (75)	85	92	97	75	87	96	8	16	30	14	27	53

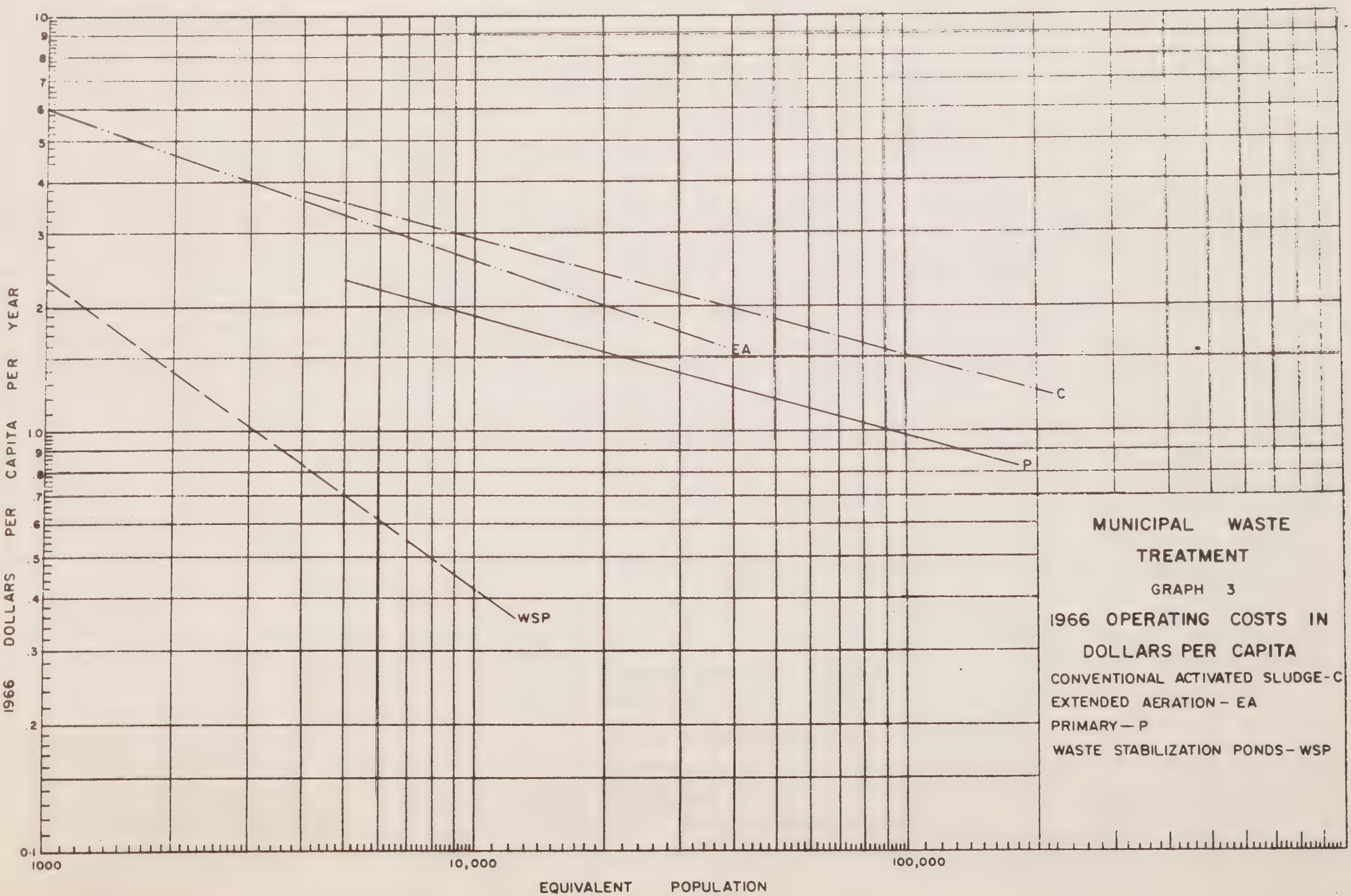
TABLE 2. MUNICIPAL WASTE TREATMENT - ACTIVATED SLUDGE MODIFICATIONS

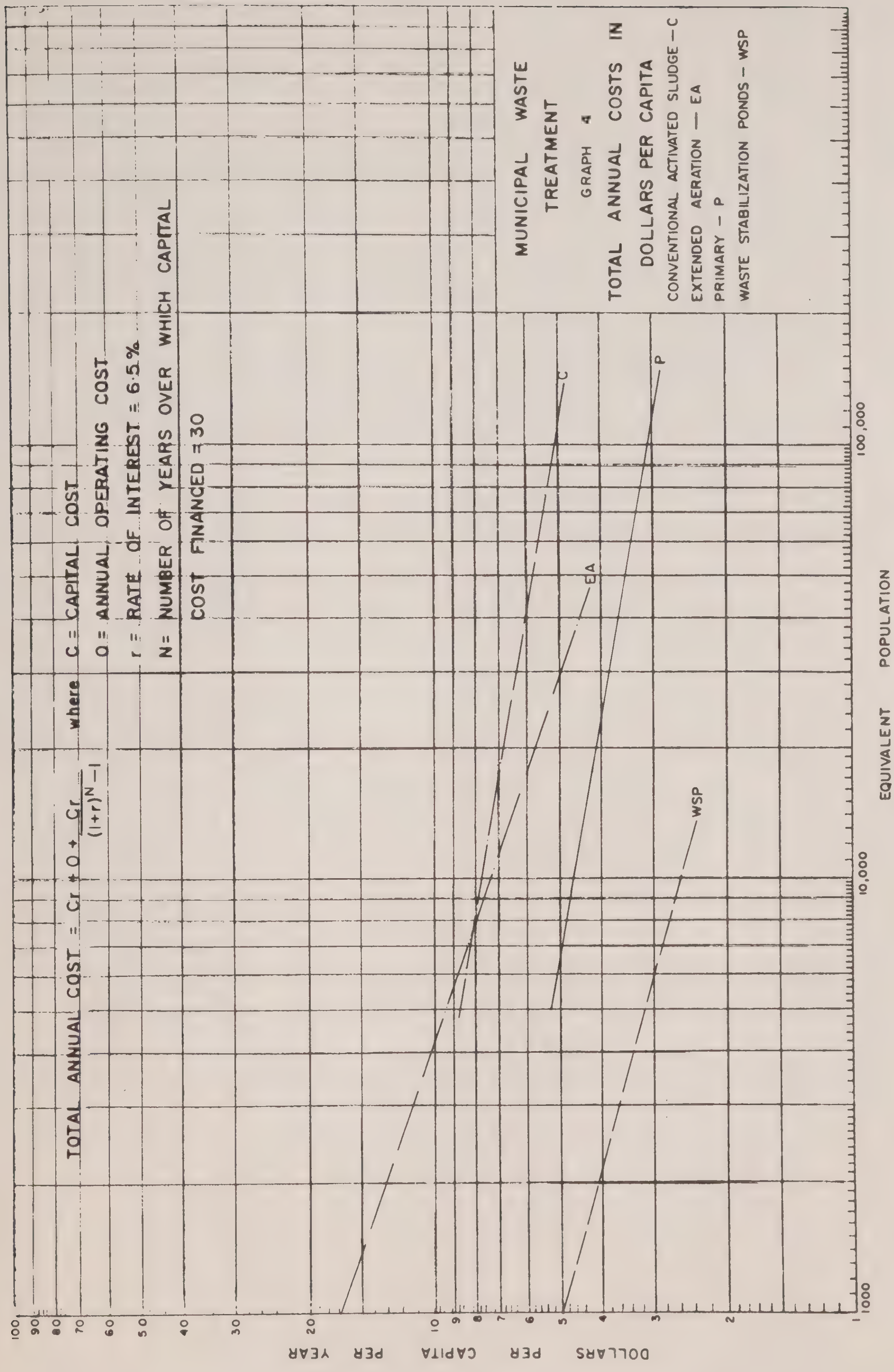
PER CENT TREATMENT EFFICIENCIES AND EFFLUENT QUALITY

PROCESS (Number of Plants Reporting	PER CENT EFFICIENCY						EFFLUENT QUALITY - PPM					
	BOD_5			Suspended Solids			BOD_5			Suspended Solids		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Conventional (75)	85	92	97	75	87	96	8	16	30	14	27	53
Extended Aeration (35)	85	95	98	73	90	97	3	9	28	6	17	55
Rapid Bloc (10)	85	93	97	85	92	97	7	14	31	6	14	28
Contact Stabilization (4)	90	92	97	80	90	98	5	13	18	3	21	38
Oxidation Ditch (3)	85	95	98	80	87	95	5	14	30	12	27	40


MUNICIPAL WASTE TREATMENT
GRAPH I
PLANT CONSTRUCTION COSTS
(EXCLUDING LAND, ENGINEERING & CONTINGENCIES)
TORONTO E. N. R. INDEX 950
PRIMARY AND BIOLOGICAL
PRIMARY
CONVENTIONAL ACTIVATED SLUDGE
TRICKLING FILTERS
WASTE STABILIZATION PONDS
AERATED ALGAE LAGOON
AERATED ACTIVATED SLUDGE LAGOON
C
P
F
WSP
AERATED ALGAE LAGOON
AERATED ACTIVATED SLUDGE LAGOON
1967 DOLLARS PER CAPITA
EQUIVALENT POPULATION
1000
10,000
100,000
10
20
30
40
50
60
70
80
90
100
200
300
400


MUNICIPAL WASTE TREATMENT
GRAPH 2
PLANT CONSTRUCTION COSTS
(EXCLUDING LAND, ENGINEERING & CONTINGENCIES)
TORONTO E. N. R. INDEX 950
ACTIVATED SLUDGE MODIFICATIONS
CONVENTIONAL
EXTENDED AERATION
CONTACT STABILIZATION
RAPID BLOC
OXIDATION DITCH
C
EA
CS
OD
RB
1967 DOLLARS PER CAPITA
EQUIVALENT POPULATION
400
300
200
100
90
80
70
60
50
40
30
20
10
1000
10,000
100,000


MUNICIPAL WASTE TREATMENT
GRAPH 3
1966 OPERATING COSTS IN DOLLARS PER CAPITA
CONVENTIONAL ACTIVATED SLUDGE-C
EXTENDED AERATION - EA
PRIMARY — P
WASTE STABILIZATION PONDS - WSP
C
P
EA
WSP
1966 DOLLARS PER CAPITA PER YEAR
EQUIVALENT POPULATION
1000
10,000
100,000
0.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
2
3
4
5
6
7
8
9
10



TOTAL ANNUAL COST = Cr + O + Cr / ((1+r)^N − 1) where C = CAPITAL COST
O = ANNUAL OPERATING COST
r = RATE OF INTEREST = 6.5%
N = NUMBER OF YEARS OVER WHICH CAPITAL COST FINANCED = 30
MUNICIPAL WASTE TREATMENT
GRAPH 4
TOTAL ANNUAL COSTS IN DOLLARS PER CAPITA
CONVENTIONAL ACTIVATED SLUDGE — C
EXTENDED AERATION — EA
PRIMARY — P
WASTE STABILIZATION PONDS — WSP
C
EA
P
WSP
DOLLARS PER CAPITA PER YEAR
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
1000
10,000
100,000
EQUIVALENT POPULATION

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"SYSTEMS APPROACH TO POLLUTION CONTROL"

DR. JOHN A. LOGAN,
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TERRE HAUTE, INDIANA

Pollution control is in a state of transition and its objectives are changing rapidly. They are different today than they were twenty-five years ago and they will, undoubtedly, change during the next twenty-five years. The goals of pollution control are no longer limited to the elimination of disease or the abatement of nuisances; our objectives today, while they still encompass disease and nuisance, are also concerned with aesthetics, conservation and the quality of the environment or, more broadly, the well-being of mankind.

From the point of view of responsible men and women everywhere there is growing concern about the by-products of civilization, particularly those of industry and agriculture. There is concern about the modern metropolis as a place to live and work; about the form and quality of the urban environment; concern about the condition of our air resources; the status of our water supplies, of rivers and lakes; with water, soil and air pollution; with urban blight; with litter and unsightliness, and with the characters of man's physical environment as it is rapidly being evolved.

The dissatisfaction associated with much of these by-products of modern civilization is not due to the lack of ability of engineers, scientists or health workers; it is rather because of limited professional objectives. The same know-how used in achieving limited objectives could be effectively used to advance the broader goals of well-being. Progress is being made. New concepts of environmental health engineering, water resources, air resources, metropolitan and regional planning are evolving; in every case horizons are being expanded and single-purpose concepts are giving way to multipurpose development. While we struggle with specific goals and objectives, both theory and practice are moving towards a broader and more liberal interpretation of society's social responsibilities.

Much of our thinking is still too limited and too narrow. W. A. Arrowsmith of the University of Texas speaks of modern engineering design as modern chaos ... "in which the environment as a whole is nobody's business and bears nobody's design -- a conglomerate whose total disorder is exposed by the ruthless design-perfection of the parts of their unrelatedness. Modern chaos is a matter of hard, individuated design, separate systems exhibiting neither link nor coherence -- a dither of unrelated, and unyielding concrete. If the parts mostly show superb technical skill, these skills flourish in a general vacuum of design. Thus, for instance, we have extremely sophisticated medical research carried on with remarkable disregard for the social causes of disease; or hydroelectric systems which manage to create a wasteland in the name of life; reclamation programs which, for want of a civil context, desolate."

"What is now needed, if we are to survive the chaos created through too technical a concentration on limited goals -- is nothing less than -- a new discipline of the whole and its implied priorities, a task in which humanists, scientists and technicians must all have a part."

Systems Analysis

This new discipline might very well be Systems Analysis, a philosophy now being adopted in such widespread areas as Washington, Edmonton, London, New York, Geneva and elsewhere. It has particular significance to Canadian conditions and will, undoubtedly, be widely used in Canada in future years.

Systems Analysis received its greatest impetus during World War II. Unpleasant as war is and as unsatisfactory as it may be as a method of settling differences, it is a time of unprecedented technological development. For example, the helicopter in the present conflict in Vietnam is undergoing a process of improvement which might take thirty to forty years under normal peacetime conditions.

World War II produced some notable technological advances, including jet power, nuclear fission, radar, penicillin and DDT. Important, however, as these are, FORTUNE MAGAZINE recently stated that one of the most important inventions coming from World War II might not be considered as an invention at all; the development of Systems Analysis.

Systems Analysis is a new way of problem solving, choosing, decision making or planning. Its value has been publicly demonstrated by the United States Department of Defense; the Department has not confined its research to the improvement of existing weapons' systems but a great deal of effort has, instead, been devoted to larger "systems" such as global defense strategy for the years ahead; this has resulted in the analysis of sub-systems in which individual weapons can be studied more logically.

As with a number of other inventions, Systems Analysis was developed by the British, perhaps originally conceived by Charles Darwin in some of his preliminary studies on evolution. It was further developed by the British civil engineer, Lanchester, early in the present century but was forgotten until World War II. At that time, scientists and engineers attached to the Royal Air Force developed a defense system utilizing the fighter command, radar, anti-aircraft guns and captive balloons to win a decisive victory in the Battle of Britain. The same consultants were again called in to aid in the development of more effective submarine control, and developed search and destroy missions for the North Atlantic which were highly effective; they dramatically improved the previous randomly-planned Allied operations.

Systems Analysis was used to a lesser extent in the United States during World War II and proved sufficiently promising to attract the attention of industry.

The Systems approach can be considered from two extreme positions with a wide range in between; at one end of the spectrum the important criterion is the construct of a problem in the knowledge that the correct solution may be inherent in its proper formulation; at the other end is the need for highly sophisticated mathematical solutions to the alternative solutions which have been suggested.

It has been said that Systems Analysis may well become a distinct United States characteristic and that it will play an increasingly important role in business, education, planning and overseas development in the years ahead.

Environmental Health

Parallel with the development of Systems Analysis there has been another quiet revolution taking place, this one in the field of public health. The United States and Canada have led the world in the development of co-operation between

doctors, engineers and other professional personnel in the health field. Our public water supplies, waste disposal facilities and air pollution devices have been the best in the world. These have had as operating criteria the control or elimination of disease, and outstanding results have been achieved in attaining these objectives. However, concomitantly with disease reduction we have seen growing air, water and soil pollution, accompanied by widespread litter, urban blight and decay.

Environmental health became possible with the acceptance of the World Health Organization as an integral unit of the United Nations. The World Health Organization took as its philosophy a basically new concept of health, one which stated that health was not merely the absence of disease or infirmity but was rather a positive sense of physical, mental and social well-being. This concept made it possible to include aesthetics, comfort, convenience and the quality of the environment as important health objectives.

This in turn has lead to a re-examination of man's relationship to his water, land and air environment, with the goal not merely of elminating disease, but of conserving and developing the environment to achieve the most pleasant and satisfactory living conditions possible.

Environmental health is a distinctly western approach to the public health problem. It involves an understanding of the multi-purpose uses for which our resources may be used; it involves both area and regional planning; it involves a basic understanding of the kind of environment which we want today and that which we intend to leave as a heritage for future generations to come.

It is only natural that the Systems Analysis techniques have been applied to the environmental health field in carrying out the kind of planning which is large scale enough and significant enough to meet the important challenges which lie ahead. The combination of the two approaches offer a new opportunity to those in the health field to rectify some of the environmental insults which have resulted from past practice and the development for the future of the kind of living environment which will be more nearly in keeping with our hopes and aspirations.

Basic to any provincial, regional or country-wide environmental health planning group should be a Systems Analysis team similar to that recommended by the United States Public Health Service in the Report of the Committee on Environmental Health Problems[1]. The primary purpose of this group would be: "to engage in and develop studies designed to clarify the relationship between the environment and health and to explain the ecological processes which affect the quality of man's environment." The group would engage in the following kinds of studies:

1. Epidemiological studies of the new physiologic, economic and social effects of multiple and simultaneous low-level environment exposures on urban population;

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[1] Report of Committee on Environmental Health Problems. PHS Publication No. 908; U.S.G.P.O. Washington: 1962, p. 46.

2. Consideration of the environmental criteria to be used by regional and metropolitan planning groups; and

3. Long-range studies of environmental health problems.

As an integral part of the Systems Analysis team should be a small group (including both analytically-trained as well as more liberally-educated members) whose primary mission would be planning both research and environmental goals and objectives. The Systems Analysis team would also be responsible for a continual evaluation of attainment, together with a re-evaluation of goals and objectives in the light of accomplishments or failures.

It is inherent in the Systems concept that adequate attention be paid to the inter-relationship between the health field and education, industrial development, agriculture, recreation, etc. Where long-range planning on a national basis exists, the health planning team may be subordinate to this group; on the other hand, if the health department provides the leadership and takes the initiative, provision must be made within the health unit to provide for the interface with other social-capital or industrial development considerations.

Pollution Control

Pollution control is an integral part of any environmental health program. As indicated previously, however, water, air and land pollution cannot be limited to the problem of disease or nuisance control and must be viewed in a much broader context, that of resource utilization.

Air Pollution

Air is one of our most important natural resources and its pollution has become a matter of international concern. "Except for natural causes, polluted air is a problem of industrialization, urbanization and human mobility, all of which will continue to increase rapidly in the years ahead. The concern with air pollution in urban areas related to the emission of a variety of gases and particles, often followed by secondary reactions in the air. The pollutants come from the fuels we burn in home and factory and in transporting ourselves and our goods, from the production and processing of materials in mine and factory, from our consumption of products, and from our disposal of unwanted waste materials.

"The concentration of pollutants in the air at any time depends upon the interplay of many factors, such as the quantity being emitted, the vertical and horizontal dispersion of the pollutants from the sources, and the chemical and physical reactions that pollutants undergo before and after dispersion. Recent evidence has made clear that all metropolitan areas have limited air resources. Even in areas where the meteorological conditions are favorable, air resources are being heavily utilized, and in many cases acceptable concentration limits have been exceeded. The only recourse is source control. A combination of atmospheric capacity and the economic feasibility of control therefore will limit the air utilization and even the maximum size of a community."

"In any specific area, the atmosphere has only limited capacity to dilute and disperse contaminants discharged to it before they can cause undesirable effects. Thus, the air must be regarded as an important and limited natural resource, whose quality must be conserved in the common interest." [1]

Water Pollution

Water is another one of our most important natural resources, one which has, however, definite limitations both as to quantity and quality. Water must serve as a wide variety of uses, including public water supply, irrigation, industrial use, transportation, dilution, waste disposal, recreation, aesthetics, etc. As a resource, consideration must be given to all of these multi-purpose uses, and allocations must be determined. Pollution may be highly detrimental as in the case of public water supply or it may be an inherent part of the water use as in the case of the water carriage of wastes.

Systems Analysis offers an approach to water resource allocation based on an evaluation of costs and benefits. It is true that the social benefits of such factors as recreation are as yet not fully understood but attempts at quantification are being made and are proving useful. Entire watersheds are now being considered as systems and studies indicate the most rational use of the water, the extent of pollution which can be economically tolerated, the size and location of treatment plants, etc.

Land Pollution

The resource philosophy of land use has been slow to be adopted and its complex interrelationships are just beginning to be understood. If we are interested in maximizing the use of our land resources, pollution must be considered in the form of overcrowded buildings, dumps, billboards, sullage, derelict housing, urban blight and decay.

Systems Analysis again offers a rational approach to the solution of land use through planning and cost benefit analysis. To be successful, planning must be both comprehensive and long-range and it must predict as accurately as possible both the benefits and adverse effects of any action taken.

The Multipurpose Concept

To be successful, planning must be both comprehensive and long-range; it must predict as accurately as possible both benefits and adverse effects.

Quoting from the World Health Organization Expert Committee Report on Metropolitan Planning: "Whereas the control and reservation of land might appear at first sight to be sufficient to assure the success of any long-range plan, water and air must also be included. All three provide different degrees of

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[1] Report of the Committee on Environmental Health Problems. PHS Publication No. 908; U.S.G.P.O. Washington: 1962, p. 71.

'open space', and each should be used in the best interests of the community as a whole. Open land (and to a lesser extent, water) can be effectively used as a relief from built-up areas for recreational and aesthetic purposes; in the form of woodland as a protective belt against noise, vibration, and undesirable activities; as a green belt to separate urban areas, to conserve the natural and agricultural landscape, and to contain expansion. The multiple uses of open space have not yet been fully exploited."

"To assure future generations of their birthright, immediate steps must be taken in many parts of the world to control gross pollution of air, land and water. Concomitant measures must also be taken to guard against pollution and degradation in the future."

"Pollution, the most obvious destroyer of our resources, takes many forms. In extensive areas throughout the world, land pollution by faeces and sullage water is a direct menace to health. Moreover, mine wastes, large-scale industrial dereliction, the indiscriminate dumping of garbage and refuse, erosion, sand and gravel pits, etc., are all taking a heavy toll of important land resources. Water pollution is perhaps the easiest form to recognize. Although water is a resource to be shared by industry, power, transport, agriculture, and communities, as well as individuals, far too often self-interest prevails and irreparable damage results. Air pollution is particularly severe in a limited number of places, and air must be increasingly regarded as a world resource to be conserved and utilized in perpetuity."[1]

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1 Environmental Health Aspects of Metropolitan Planning and Development. World Health Organization Technical Report Series No. 297, Geneva, 1965, p. 14.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"LAND USE PLANNING FOR POLLUTION CONTROL"

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KNOWLTON, QUEBEC.

By now, I am sure that most of you have had a bellyful about pollution. I can think of some things that I wouldn't mind talking about for two and a half days steady; but pollution ... This is not to imply any criticism of the organizers of this conference. In fact, I think Mr. Voege and his program committee have done a great job of glamorizing pollution for us. If variety is the spice of life, pollution is a real gas; according to the conference program, we've got all kinds here -- air, water, soil, agricultural, industrial, municipal, animal, vegetable, mineral, even radioactive. Nothing old-fashioned about us; once again, Ontario leads the nation. Pollution is so popular we even have films about it.

But in spite of Mr. Voege's most inspired efforts, two and a half days of discussion on pollution is a somewhat sobering experience. And the word is not inappropriate. In a sense, today's society is suffering the after-effects of a real bender. In fact, most of us are still out on the town.

What we have done is simple: with blithe disregard for the consequences, we have for years made excessive use of something that is even more precious to mankind than booze: the capacity of our environment to handle waste.

Because waste handling is what we are talking about at this conference. At the risk of repeating some material from earlier papers, to avoid any misunderstanding I will briefly summarize the concept of pollution on which this paper is based.

All of us, whether in agriculture, industry or municipal government, are engaged in the production of goods and services. This economic activity uses resources of one kind or another, and in addition to the main product which is the object of the exercise, it results in most cases in the production of one or more by-products. Some of these by-products can be sold, possibly after further transformation. But there are nearly always some which cannot. These uneconomic by-products of our economic activities are what we call waste products. The whole problem of pollution, in the usual sense of the word, is caused by the way we dispose of these waste products. In other words, pollution control, as far as human activity is concerned, is purely a problem of waste management.

We have traditionally used the basic elements of our environment -- air, water and soil -- for waste disposal. Below a certain density of population, or below a certain level of economic activity, we can get away with this, because each of these three elements has a certain capacity to assimilate most kinds of waste. It is when we exceed this natural assimilative capacity of the environment, whether in terms of its intrinsic level of tolerance, or in terms of our own willingness to tolerate certain levels of environmental quality, that we produce the phenomenon we call pollution. Pollution, then, is putting more waste products into a given environment than it, or we, are prepared to tolerate.

For a long time, we tended to assume that our lakes and rivers could handle anything we dumped into them, that the air could look after an infinite quantity of smoke and other discharges, and that the land would break down and absorb whatever we put on it. This mentality was the origin of our great bender. It has taken us quite awhile to realize that we have been overloading the system. In cases where such overloading has already caused permanent or long-term damage, society as a whole is to blame, because we all tolerated the practice of relying on the natural action of the environment to dispose of most of our waste products for us. It is only recently that we have come to see that this

natural assimilative capacity of air, water and soil is a limited natural resource belonging to society as a whole, and in allowing people to use it indiscriminately for getting rid of their waste, we have been giving them a free ride at society's expense.

For one thing is clear: the primary responsibility for waste disposal lies with the person or group that produces the waste products in the first place. If he does not wish to fulfil this responsibility, he may delegate it to someone else, or pay someone to do it for him; but the original responsibility remains his.

This rather roundabout introduction now brings me to my topic: land-use planning for pollution control.

First of all, what do we mean by pollution control? We mean the management of waste products in such a way that they do not exceed acceptable limits of concentration in a given environment. This raises two preliminary considerations: one, we should encourage our producers of goods and services to carry out their operations in such a way as to produce the least possible quantity of uneconomic by-products; and two, we should encourage research aimed at finding economic uses for by-products now considered uneconomic. In other words, it should be our general policy in pollution control to keep waste products to a minimum, and then to find uses for this minimum.

Now, what about the remaining unusable, uneconomic waste products? Our objective is to keep their concentration in a given environment below acceptable limits. Obviously then, the first thing we have to do is define what are acceptable limits for a given waste product in a given environment. Since all three basic elements of our environment are used for many purposes, of which waste disposal is only one, this is primarily a political question, and must be determined by government after democratic consultation.

And this, in my view, is what we mean by land-use planning for pollution control. Essentially, men use land in two basic ways: to live on, and to live off. What do I mean by this paradox? Well, man lives <u>on</u> the land in the sense that it forms his primary habitat. Man is a land-based animal, and land is a primary component of his basic environment (or biosphere, to use a two-dollar word). Man also lives <u>off</u> the land, in the sense that the land constitutes his primary source of the resources he needs to live. As our economy becomes less and less resource-based, that is more independent of the primary extractive sector of agriculture, forestry and mining, the habitat aspect of land increases in importance in relation to the resource aspect. This is one of the factors that has led to growing public concern about pollution, as we are less prepared to tolerate environmental deterioration in the interests of the production of wealth. Furthermore, as the age of leisure creeps slowly up on us -- I would even say imperceptibly -- we place a greater importance on the use of the environment for recreation. These two uses of land -- for living and for producing -- often conflict with one another, and the first job of the pollution control planner -- namely the government -- is to strike a balance between them that is acceptable to the people concerned. As our economy and our technology evolve, this balance will inevitably alter.

Before I go more deeply into this question of land use, two observations should be made concerning the other two elements of our basic environment. In the first place, all land forms part of a watershed. This fact, together with

water's felicitous property of unquestioning obedience to the law of gravity, is what permits us to make such extensive use -- or abuse -- of water for waste disposal. In the second place, the four winds blow eternally over the face of the earth, prompting man to spew into the air whatever he can that he doesn't want around home but can't throw into a river. The remainder of our wastes, of course, we just leave sitting on -- or sometimes in -- the land itself, preferably on someone else's property.

Therefore land-use planning for pollution control involves not only land, but also the water and air that flow over that land. All three elements have, as I have said, a certain capacity to assimilate waste products. This capacity depends chiefly on the kind of product, its concentration, and a time factor; and also, in the case of air and water, the quality and rate of flow of the air or water. Other factors, such as temperature, sunlight, etc., also affect this assimilative capacity. But in principle, the capacity of a given environment to assimilate a given substance in a given time, without permanent environmental deterioration, can be approximately measured. A maximum biological or ecological load for a given environment can therefore be established, which would make full use of its natural assimilative capacity without causing permanent damage. Ideally this would be the first thing a land-use planner should know when considering pollution control. He could then recommend the location of waste-producing activities so as to take maximum advantage of the environment. Access to this capacity, being a public good, should be regulated by government, possibly by licensing.

The trouble is, we are already not only using but in most cases considerably exceeding the natural capacity of our environment to absorb waste products. Indeed, this is the very definition of pollution. At this point, the question arises as to the desirability of using some sectors of the environment for waste disposal at the expense of other possible uses. In the case of a river, we might decide that for ten miles downstream from a factory we would sacrifice fish, swimming and water supply in the interests of waste disposal for the factory. Obviously, such a decision must not be made unilaterally. It is a matter that concerns all the residents of the area, and perhaps others besides. If, for example, the river is a well-known salmon river, or particularly beautiful for boating and swimming, it may have users from far beyond its immediate area. In today's mobile urban society, comparatively few people own land on a salmon river; but we nevertheless feel that we have a right to enjoy the recreational benefits of rural land ownership, and that it is up to government to provide them, through parks, hunting and fishing reserves, and so on. Therefore it is up to government to settle disputes concerning conflicting uses of resources where the public interest is affected.

In the case of water, the best mechanism for reconciling conflicting interests is probably a watershed authority, set up by government with representation from the major interest groups in the watershed. This provides a forum where the factory owner can argue his case for waste disposal, invoking the high cost of treatment, the number of jobs his factory provides, and the fact that his competitors don't treat their wastes. The fishermen and the conservationists can have their say, and the average citizen can make a plea for preserving some of the natural beauty that he knows is there but seldom sees.

In view of our principle that each waste producer is primarily responsible for disposing of his own wastes, and in view of the fact that our rivers are public

assets, even if in some cases they are privately controlled; in view of these considerations, if the watershed authority decides in favor of the factory owner, this does not mean he should be allowed to dump his waste products into the river free of charge and forever. He is being granted a privilege by society, and he must pay for this privilege, probably through the purchase of a license or the payment of a tax or fee. Moreover his use of this privilege must be carefully controlled and policed, and subject to revocation after a reasonable notice if the public interest should require it. For I want to make one thing clear: no man has a sovereign right to use the common environment for disposing of his wastes. As I said earlier, for a long time society allowed us to behave as if this was a sovereign right, on the tacit presumption that air, water and soil were free and inexhaustible. But government is finally asserting its latent authority, and no industry, no farmer and no municipality can claim a right to pollute, whether inherent or acquired.

If it is decided that a particular lake or river cannot be used for waste disposal, because it is needed for water supply or recreation or some high-quality use, those who used to use it for this purpose must fall back on their own resources, and dispose of their wastes some other way, at their own expense, and without prejudice to others.

In the case of air, the problem is at once simpler and more difficult. It is not as easy to calculate the assimilative capacity of air, as its flow is less regular and reliable than that of water. The extent of damage to the surrounding environment, including human beings, likely to be caused by fallout or suspended matter is also more difficult to estimate. On the other hand, the conflicting uses of air are fewer, the sources of pollution more visible and the occurrences generally fewer than in the case of water. The usual control practice is to set a limit of tolerance for various substances, to take continuous measurements, and to try to diminish production of waste products if the level gets too high. In view of the danger of temperature inversions and freak conditions, a wiser practice would be to concentrate on eliminating airborne products at their source. This is becoming more feasible and cheaper as techniques improve. In the meantime, air polluters as well should be controlled by law and licensed if necessary. The optimum location is obviously upwind of an uninhabited area, but this is almost impossible to ensure. Through fallout, air pollutants also become soil pollutants and water pollutants.

Several waste products lend themselves to various kinds of treatment or disposal -- for example, rubbish can be dumped, incinerated or buried. The best procedure in each case should probably be determined by a local authority, possibly municipal government.

Soil pollution is generally associated with farming, and with the accumulation of undesirable residues of herbicides or pesticides in the soil. This is largely a technical problem of determining levels of assimilation and tolerance, since there is still less of a question of conflicting uses. But soil pollution illustrates again the close link between contamination of one medium and contamination of another, for farm runoff can carry a proportion of these harmful residues into the water system.

Here is where land use planning for pollution control becomes vitally important. In my own area, in the Eastern Townships of Quebec, we have a well-known lake called Brome Lake that is gradually eutrophying because of

excessive growth of algae in the summer. This algal pollution is caused by the entry into the lake of excessive quantities of nutrients in the form of nitrates and phosphates -- in other words, fertilizer for the algae, which bloom, decompose, absorb the lake's oxygen, kill fish, and silt the lake bottom, as well as turning the surface green and putrid three or four times a summer.

This algal pollution could be largely cured if we could stop the entry of nitrates and phosphates into the lake. Where do they come from? Largely from insufficiently treated domestic and municipal sewage, but also from farm and natural runoff. This runoff could be largely purified of phosphates and nitrates by proper land use -- contour ploughing, better fertilization practices, and especially better maintenance of uncultivated land, through reforestation and other measures to prevent gullying and erosion. Poor land use planning is endangering our most valuable natural resource, the focal point of our recreation-based economy -- Brome Lake.

To summarize the theme of this paper, land use planning for pollution control is really a problem of land, water and air use planning for waste management. Waste-producing activities should be located so as to take maximum advantage, by licence, of the natural assimilative capacity of the environment. To use the environment beyond that capacity for purposes of waste disposal should require the consent of a majority of interested parties, sanctioned by public authority, and compensated by fees or taxes. As a privilege, it is revocable. In any case, everything possible should be done to limit the penetration into the environment of waste products, and good soil and water conservation practices should be encouraged by persuasion, tax incentives and even law. In a given watershed or airshed, conflicting activities can be located in a descending order of demand for pure water or air, so that the upstream activity does not exclude any of the downstream activities. All such locational planning must be subject to public authority and supervision.

Finally, the principle that the waste producer should be primarily responsible for his own waste disposal is not only legally and morally sound, it is ecologically sound as well. For if we view the world as a series of self-sustaining interrelated ecological systems, of which human communities are simply one variety, it is wise for humanity to intervene as little as possible in the operation and functions of the ecosystems around us, simply because we do not know what the full effect of such intervention might be. This means that we should not fill the whole environment with our wastes, but rather dispose of them ourselves and return them to other systems in a form they can absorb without harm. To do otherwise might result in strangling and destroying the very environment from which we sprang, and on which we still in large measure depend.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"THE SUPER PROBLEMS OF MODERN SOCIETY"

DR. E. G. PLEVA,
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The Fitness of the Environment

Lawrence J. Henderson, in his book "The Fitness of the Environment" published in 1913, wrote as his topic sentence in Chapter 1, "Ideas of purpose and order are among the first concepts regarding their environment which appear, as vague anticipations of philosophy and science, in the minds of men."

Civilized man, or at least those who aspire to be civilized, is still trying to work out the compatibility of purpose and order. This is why we are here today. We want to know the limits of adaptability in the human condition so that we may enjoy our physical resources of the environment without lessening or destroying the resource base. To what extent can the environment be altered without lessening its fitness for human survival? Man, through his technology, has extended the capabilities of the environment. This is granted. We hold no brief against progress. However, the challenge to earthlings rests in the question, "How can the benefits of an advancing technology be had without affecting adversely the primary resource base or altering the environment to such an extent that the limits of man's adaptability may be pressed or exceeded, thereby making the survival of man unsure?"

Environment, in the first instance, must be given the widest possible definition. Certainly we may start by saying that it, the environment, comprises all the physical, regional, and circumstantial conditions that influence the life and development of an individual or a community.

The Tolerable Limits

I thought a long time before I decided to use the word "tolerable" in this context. However, when trying out the word with students I got exactly the kind of response I wanted. Rather than getting tied up with a discussion of verbal perception and meaning I prefer to describe what I mean by the term, "the tolerable limits".

Man is an adaptable creature. It is true that each of us recapitulates the three stages of resource utilization: appropriative, adaptive, and creative, yet it is the adaptive stage that characterizes our condition most of all.

Our mastery of the environment is almost exclusively adaptive. Our being in this room is a testimony to adaptive skils: a conditioned climate, clothing to provide a personal microclimate, a diet gathered all over the world and available whether in season or not, mechanical (usually personal) transportation to get us here, a communicating language reinforced by machinery, and (perhaps most important of all) a division of labor that enables us to have the time to gather here to discuss the question whether all this progress may not carry along with its benefits the seeds of destruction.

Man adaptiveness is related almost exclusively to the manipulation of resources to provide what man obviously believes to be something closer to some kind of optimal environment. What is an optimum condition? We are just beginning a research look at the concept of "optimum" in such things as housing, urban design, transportation systems, air and water standards, and allocations of land uses. This conference may make a significant contribution because it is addressing itself to the problem of environmental pollution, a subject now recognized as completely relevant to our survival possibilities, and furthermore, a

subject on which solid factual data may be more readily obtainable than in more complicated parts of the social web. In many ways, the procedures whereby you deal with environmental planning will be useful to all who study the human condition. I do not imply that scientists and the scientific method alone will provide the answers to our human problems. In fact, it is now evident that scientists cannot do the job alone in understanding the problems of pollution nor in recommending procedures for pollution control and abatement.

Too many people have an idea that the so-called balance of nature is a razor's edge affair where the slightest aberration has irreversible consequences. This is too simple a concept. On the other hand, neither is the balance of nature a log jam affair where only excessive charges of dynamite have an effect. In every environmental relationship the true condition is somehwere in between. What the tolerable limits in thousands, perhaps millions of complicated relationships are is the concern of all of us dealing with environmental problems.

The Rise of Urban Man and the Industrial Economy

The world's rapid rise in population to a present three and a half billion with a possible seven billion by the end of the century is a reflection of technological advancement. A world-wide economy that reaches into all parts of the human world has affected the capability of the terrestrial environment to sustain life. The widening of a productivity gap between different groups of the world's people does not negate the fact that even the lowest income groups in our world family have increased their capability to produce and sustain larger populations.

The fact of increased urbanization is worldwide. In North America it is apparent to us because this is where we live and because we are rapidly moving to a ninety per cent urbanization factor.

Urbanization means a concentration of humans. The packing together of people and their machinery has had serious consequences in many areas and may have affected the fitness of the environment not only locally but regionally. Some serious scholars maintain that some of the consequences of pollution are already worldwide.

A first principle in environmental planning implies an understanding of the causes of any specific kind of pollution and to deal with it at the point where it is discharged into the environment. Let us, however, continue to keep our definition of pollution as inclusive as possible. Pollution is any kind of damage that adversely affects man's welfare as an earthling. Remediable pollution includes those kinds of damage which can be prevented, abated, or controlled so that the tolerable limits of environmental fitness are not exceeded.

What is the city of tomorrow? I say "city of tomorrow" because the world of tomorrow will be even more urban than it is today. How do we work toward a human habitat that gives every man a chance to improve his own individual lot without lessening the resource capabilities of his fellow men? This is a mighty challenge. Scientists all over the world tend to be fired by this challenge. All others seem to be pessimistic.

Each of us belongs to two societies: one, the society of science and technology where we know we are just entering the creative stage of our development;

and, the other, a society of hard political and economic reality where even if we were allowed to do it, we would not be able to afford it.

The Civilized Landscape

Let us start with the human habitat. I talk to my students as soon as I meet them about what I call the civilized landscape. What do I mean by this? I tell the students that man's needs from the environment includes many legitimate land uses: space for houses, industries, water supply, roads, hospitals, shopping centers, cemeteries, parks, schools, farms, mines and quarries, grazing land, docks, television towers, canals, airports, forests, electrical energy installations, hotels, libraries, theaters, recreational areas, wilderness, scenic vistas, airports, sewers and sewage disposal systems, and at least a score of other major land use needs. All these are legitimate; all are needed. The challenge of the civilized landscape is to see that each use is put in its right place and that each legitimate use does not detract from the maximum effectiveness of every other legitimate land use.

This challenge sounds terrifying, yet I have found the young scholars eager to accept it. What do we really know about the impossible when we have not even touched the limits of the possible? What is possible? All around us we see examples of what can be done. Surely the major effectiveness of a conference such as this is to transfer what has been done somewhere to some other place where it is needed. I am not so much worried about what we don't know as by the ineffectiveness with which we apply to problem solving those things we already know. Please do not misunderstand me. I believe in what is called pure research but usually the real breakthroughs come at the edge of knowledge in the work of someone (I consider a "team" as a someone) applying what is already known to a new problem situation.

We will need to use all of our skills as well as the material products of an abundant resource base to achieve the civilized landscape. Before we look at this challenge more specifically, we must assess our present condition in Ontario.

The Grand Trunk Corridor: An Area of Concern

I believe the major problem in Ontario today is related to a rational development of urban growth on a regional scale.

The most important industrial and urban agglomeration in Canada parallels the axis of the lower Great Lakes and the St. Lawrence River. A map of Canada shows that a relatively straight line may be drawn from Quebec City through Montreal, Kingston, Toronto, London to Windsor, approximately 700 miles long. If one visualizes a belt 50 miles wide (25 miles on each side of the imaginary line) running its entire length, the belt or corridor would be 35,000 square miles in area. Although this comprises less than 1 per cent of the total area of Canada, this corridor is an extremely important part of the country; for it contains approximately three-fifths of Canada's population, four-fifths of the industrial activity as measured by the value of manufactured goods, and one-third of the commercial agriculture as measured by the value of products sold off the farm. One of Canada's railway champions, Alexander Galt, named this

corridor a century ago. When arguing for a railway to run from the salt water of the St. Lawrence estuary to the heart of the continent in Chicago, he said, "This railway will serve the Grand Trunk of North America."

It is in the Grand Trunk Corridor of Ontario where the greatest opportunities for development are, also it is the most critical area for pollution control and abatement.

Some Examples of the Impact of Developmental Problems on Environmental Balance

Environmental problems tend to be regional, yet regional approaches to regional problems are lacking or are in the first stages of evolution. Our effective living space covers many jurisdictions of local government. You do not know where you live in the way your grandfather knew, yet you still operate in his boundaries.

A large assembly factory comes to a rural area. Picture a factory in the corn fields living in thirty towns and villages. The consequences to municipal financing in terms of services are complicated. Should the location of a large factory in a rural area trigger an urban growth of the surrounding area?

A large thermal power station is being built on the shore of Lake Erie. Several thousand workers are needed during construction but only a few hundred workers will be needed when plant is operative and run from a computerized control center a hundred miles away.

Cities have financial problems as they deal with development and renewal. The Ontario Municipal Board claims many cities are at their debt limits and no longer may burden future taxpayers with large debt charges. Nearby municipalities with relatively unencumbered debit columns may look very attractive to developers.

Several government departments have hinted at the possibility of massive extensions of water and sewer services beyond urban boundaries to open up new housing areas, thereby pushing down building costs in the older urban areas. What problems will such a happening solve; what problems will this create?

Several government officials have recommended the establishment of new towns and satellite communities. Who decides where these shall be located?

Some industries commonly considered "fixed" are beginning to show signs of becoming "footloose". "Early start" locations may be more costly than "new" factories in achieving today's necessary pollution abatement and pollution control levels. Industries as large and complicated as the automobile, steel, and petrochemical industries show strong tendencies to move and expand to new locations along the Grand Trunk Corridor.

Agriculture is a major industry in Southern Ontario. Kent County, for example, has a commercial agricultural output greater than that of the four combined Atlantic Provinces. Much of the best agricultural land in Ontario is in the shadow of urban growth. Can a prosperous agriculture and an expanding urbanism exist in the same region?

The urban areas will expand spatially at a greater rate than the population increase justifies. The spread of cities is a reflection of the fact that the preferred form of housing is the single family detached home, usually in suburbia. The preferred form of personal mechanical transportation is the automobile, which in turn encourages the growth of a sprawling metropolitan area thereby putting a strain on existing roads and creating a need for expanded road systems. At the same time the costs of services and education increase rapidly.

An expanding urban area puts a shadow of influence out beyond its limits. Even the problem of solid wastes has regional implications. Thousands of tons of materials are each day moved into every megacenter. These materials are used, discarded, and become a disposal problem. Where is the "away" in "Throw it away?"

Ontario has an exceedingly large stake in the maintenance and improvement of the quality of the environment in the Great Lakes - St. Lawrence drainage basin. Yet in this great drainage basin the quality of the surface waters, rivers, and lakes, and even that of groundwater, is decreasing from year to year. The physical map of North America shows a natural unit of the Great Lakes - St. Lawrence drainage basin: it is one system. The political map, however, displays a pattern of fragmentation. This natural unit is shared by the United States and Canada: by the nine states of Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, and Vermont; and by the two provinces of Ontario and Quebec. It is generally realized that the local government units of a century ago are inadequate to meet the problem of today's expanding urban areas; but it is not so well known that historically evolved state and provincial boundaries are great obstacles to dealing with large environmental problems. A governor can speak only for his state; a premier can refer only to things being done in his province. There is no unitary system or approach for dealing with the basic problems of this great drainage basin. Ohio cannot speak to Ontario except through the State Department and the Department of External Affairs. This process can take forty years.

Curriculum Revision and Development

Forty per cent of the population of Ontario are under twenty years of age. Most of these young people are in schools. The curricula of any community must have mobility and flexibility to change with changing conditions, in fact to be elements of change themselves.

The problems related to the maintenance and betterment of the environment are being increasingly studied in the schools through improvements in teaching the natural sciences and the social sciences. The competence of the teacher is reflected in the way he handles the new permissiveness in the curriculum. The universities have a great obligation to prepare specialized teachers who, besides competence in specialized studies, are capable of understanding man's role as both an agent and an element in the environment.

Even in the universities with their narrow specialist traditions, an interdisciplinary or broadening influence is at work. On December 7, the opening ceremony of the Environmental Engineering program at the University of Western Ontario will be held. This is one of many indications of the trend to environmental programs being undertaken in the universities of Ontario.

The Incidence of Leadership

The changing quality and fitness of the environment must be faced as challenge to all who are scholars, teachers, and scientists. It is for us to encourage our fellow scholars and students who are eclectic in their outlook to work at the interdisciplinary level as well as at their own more restrictive professional specialization. It may be difficult to find many with these inclinations, but perhaps not many are needed. The incidence of idea leadership is always thin. Perhaps our scarcest resource in the final analysis will prove to be the small hard core of individuals who have the initiative and leadership to see the environmental problems in total perspective and who are able to act to get the answers to the questions they ask themselves. Many people may ask questions but only a few are qualified to supply the answers. The best questions in the long run are those that are asked by the people who are able to answer them.

A conference such as this brings together the people who can ask the right questions and who can work to supply the answers. The questions are mighty ones: the answers are important. Our future is involved.

ONTARIO POLLUTION CONTROL CONFERENCE

DECEMBER 4, 5 & 6, 1967

"CONFERENCE SUMMARY"

MR. ARNOLD EDINBOROUGH,
PRESIDENT,
SATURDAY NIGHT PUBLICATIONS LTD.,
TORONTO, ONTARIO.

I've been given the task of putting this two-and-a-half-day conference into a twenty-minute summary, and it's like putting toothpaste back into a tube -- it isn't impossible, it's just damn difficult.

I want to say right from the start that I'm not an expert on pollution; but as a person whose office is in downtown Toronto -- three blocks from the waterfront, one block from the station and four blocks from the Pearl Street hydro plant -- I am a great consumer of it.

My trade is words, and so I have felt very much at home here in the past two-and-a-half days. As Shakespeare said in KING JOHN, "Never was I so bethumped with words since first I called my brother's father dad." And in order to prepare myself for what I have to do today I took myself home last night and between 7:30 last evening and half-past midnight I swear to you I read every single word of every single paper. And now I want to tell you, out of all that, what I think was said.

First of all, as Mr. Stockman said on Monday morning, "Pollution is a people problem". I think that is a fundamental observation. I think it was the basis of this conference; because that observation has been expanded in several ways by several people right up to the last one, Dr. Pleva, who ended almost with that same remark.

First of all, people by and large are natural polluters. Reacting against their already messy environment in the cities, they stream every weekend into the "unspoiled" countryside. And as Professor Norman Pearson said, what do they do then? They first of all stop and mess it up just as badly as the cities that they've left. They build cottages, sometimes not even proper cottages; then they get a little more civilized and they build an indoor toilet; and as a result they put septic tanks on non-absorbent granite and blame the soil for not being absorbent. After that they either burn their garbage or they just dump it somewhere which is away from them -- throw it away. Where is "away"? It's so long as it's not on your property -- that is where "away" is in the country. And they go between the two areas of "away" and "at home" in a power-boat which pollutes the water in between.

But even if they're not overt polluters, people are the cause of waste which may become a pollutant. As several speakers indicated, human sewage has polluted the Great Lakes System just as much or more than industry and agriculture combined. What is more, most of that sewage which is a polluter of water would be useful on the land; and I have learned a new technical phrase with which I shall blind my friends with science -- I'm going to start talking about "re-cycling". And that doesn't mean taking up bike riding again, it means, in fact, putting waste where it's needed instead of where it's a nuisance. That is, what is so nicely called "liquid waste". Solid waste, however, is a problem which is taxing the brains of most dedicated scientists, obviously; I heard some very way-out remarks yesterday from Mr. Ross Clark, saying "How are we going to cope with the three million tons of solid waste which is going to be available in Toronto by 1984" -- or - 6; I think 1984 was in my mind because that's when George Orwell's Utopia was to come into operation. Of course we've all been aware of solid waste: the words themselves aren't waste, but when we've digested what is on the papers which have been reproduced in the conference here somebody has to throw away 500 pounds of paper from this conference alone. In talking of that solid waste, however, Mr. Ross Clark

quoted (though he was careful to say he was quoting) a remark by Mr. May, the Chairman of the American Can Company, to the American Packaging Conference. Mr. May said: "Pollution control consultants are quite direct about cans, glass bottles, plastic bottles, metal and plastic caps and crowns and paperboard packages. They state unequivocally that one of the most difficult problems in waste disposal are these used containers and packages. Convenience packaging is rapidly becoming problem packaging -- and we're all caught right in the middle." In other words, the more we go out to work, and the more women go out to work, and we become a more affluent society, the more we want to come home and open a can, or a bottle, or a package to eat: then there's a double set of waste: liquid and solid.

And thirdly, the problem is made intensely difficult -- and this has been shown this morning by the speakers, and in previous papers -- because people will congregate in cities. And they will drive in their own cars -- one person per car; and in addition to that they will elect people who'll promise to keep their taxes down, so that automatically they cannot keep the quality of services up. There is no reasonable standard which can be maintained if, in fact, we continue to operate on just a municipal basis. I am very struck by the remark that if we want to deal with these problems -- as they must be dealt with -- on a regional basis, it takes sometimes forty years for the Governor of Ohio to speak to the Premier of Ontario. That, then, is the third thing that emerged from this conference for me, that people are the pollutants -- people separately, people in groups, and people in enormous agglomerations in our modern cities.

Now we come to industrial pollution; and with the glorious phrase, "Quite apart from the generality of the foregoing", there are two other major areas in which speakers have concentrated: industry and agriculture.

I'd like to speak of industry first, since by its very divergencies it has enormous differences in waste disposal techniques and requirements. These, I might say, were ably set out by Mr. Caplice in one of the most detailed and informative papers of this whole conference. And despite what the President of the CMA said at the luncheon on Monday, the record is not as good as it might appear. I gather from Mr. Caplice that one out of six manufacturing plants under surveillance by the O.W.R.C. is an active polluter of water in this Province; and that the pulp and paper industry, the steel industry, the nickel industry and the fruit-processing industry are the major culprits. It was such a change, in that paper, to see somebody actually naming people, instead of just pussyfooting around as sometimes this conference has done. I was in one of the discussions when somebody asked, "Why can't we make this a crime, this ... kind of pollution?", and the answer was, "I'm a civil servant and I never would say anything is a crime; even if I did, it's a federal responsibility." And so the answer -- and this has been said time and time again at this conference by both technical speakers and by the more general speakers -- the answer to industrial pollution is the expenditure of dollars, and dollars in very large amounts. And here again, Mr. Wills in his defensive speech for the manufacturers, said that -- and I quote him -- "Individual companies have taken giant strides and made their own pollution safer." -- Well, about time! -- and reminded us that one company has been spending over a million dollars a year in air-cleaning devices. He went on to say that other companies are doing the same; but I want to put the record straight. That is not an expenditure of charitable money. They do not put that on their tax deductions. That million dollars is part -- as he said right in

his speech -- ten per cent, perhaps, of a new plant. But who pays for it? Not the industry, gentlemen; we do; they put it in their prices. I can scarcely think that industry can take all the kudos for spending money which I pay them back when I buy their product. And so there again we come back to people. Even in industry it's a people problem, because if we don't buy the product they'll go broke. And Mr. Wills, I think, realizes that it was a people problem because he then took off after people for the wrong image of business, and went on for quite some time.

So much for industry; now to agriculture. I'm glad to say that from all the experts that I've listened to, generally speaking, the amount of soil pollution at the moment seems to be negligible. The real problems for farmers are, as they are for others, air and water pollution. The latter is also a private problem for industry too -- within the industry. Just as we concentrate people, farmers are now concentrating animals, especially in poultry and the hog business. In fact, they've changed their methods of farming to such a degree that what used to be a fertilizer when I was a boy on a farm, and spread lovingly over the land, is now flushed into the stream and carried down to the mouths of those rivers, where of course stand large cities; and what with hogs and people the situation at the estuary is getting pretty dirty. On the way, of course, there's a good deal of grief to the intervening farms, some of which have been drinking that same water long before battery layers and scientific hog production were thought of.

Out of all this, then, industry -- or, the general people problem, industry and agriculture -- I think there are some basic considerations which have emerged. Obviously, we are now concerned about pollution, and we must control it; we feel we must control it. And the first way of controlling anything which we deem criminal, or so anti-social as to be almost criminal, is to control it by sanctions and law. In other words, people being polluters, they have to be controlled, just as people being parkers, they also have to be controlled. And such controls, under pressure from various groups, have now been legislated for. The new Air Pollution Control Act has, I think one can say, been painstakingly detailed by several staff speakers to the conference as a whole, and to the separate sections. And similarly, in his paper yesterday, Mr. Caverly outlined the new Water Quality Objectives which are about to be promulgated and, one hopes, enforced. This followed several papers saying what the Ontario Water Resources Commission has done, and can do, in dealing with both industrial and agricultural as well as municipal delinquency. There has been a fair amount of blowing of the trumpet on behalf of the Ontario Water Resources Commission, but it is no uncertain trumpet and they don't strike many sour notes as far as I'm concerned. The Government, in other words, sees its way clear, and will proceed to act.

Yes, but when will they proceed to act? When will we stop talking and do something?

Now here we come to control by persuasion. Action can only come if the citizens of this Province can be persuaded to take it, and pay for the cost of it. Governments are in a tricky situation here; the great industrial companies give large sums of money to the democratic election process. You cut them off and you can't mount an election campaign! On the other hand, let industry ride rough-shod and the people won't elect you, even though you do have the money.

(If you don't believe it, ask Mr. Van Horne and K. C. Irvine!) It is therefore essential to get co-operation from industry and also action from people. It's essential to persuade people, therefore -- all people -- that what is at stake here is not the quality of air; it's not the quality of water; it's not the quality of land; it's the quality of life, the actual quality of the life we want to lead in this particular Province. Now, government information services (which have already been mentioned as being in the process of re-organization -- what information service is ever not in the process of re-organization?), the press, the radio and the TV -- these are the great hopes in the battle against pollution. In fact, some of the most remarkable strides in political persuasion have come within the last three months as the result of radio and television broadcasts about pollution. And you will notice that this is now becoming an OK thing. There are some things, you can talk your head off and you will never get into the newspapers; talk about pollution, birth control or abortion and you're right there. And you may notice that this conference has had good coverage on both CTV and CBC; it has had remarkably good coverage in the press; all newspapers, both evening and morning, have had up to a page and in one instance eight separate articles out of this pollution conference. Therefore the press is ready, and stands ready to help in this question of persuasion. Because we know that technical skill is essential in controlling pollution, the technical skill is already there. And where it isn't, research is actively in progress. What is lacking at the present time is the will of the people to see that pollution is controlled. And in calling this conference, I think that Prime Minister Robarts has shown once again his capacity for leadership, for putting a popular issue squarely and dispassionately in front of the people. Sometimes when I saw Mr. Robarts at the other conferences he called last week -- the "Confederation for Tomorrow Conference" -- it seemed to me that "dispassionate" is the word one uses about him, and if I may twist what Mr. Churchill said about Atlee: "A very dispassionate man, with a great deal to be very dispassionate about."

But this has not been a sensational conference -- though there are sensational facts in some of the technical papers; it has not been something which has hit the newspapers with screaming headlines; it is not the kind of conference which apparently is coming up later this week with the heading "GASP", which you've seen around; it's not been that kind of conference. It's been a solid, workaday conference where people have talked a great deal and where I hope now they will go and do something about it. Because, for me, this conference really did not need me; this conference was already summed up yesterday morning by Mr. C. H. D. Clarke, when he said:

> "Let me suggest to you again that it's not possible to find a simpler measure of a good environment than whether fish and wildlife can thrive in it. There are societies older than ours in years that have every right to claim that they're younger and healthier, because they have been able to preserve some of the freshness of youth. This happened because people had the will to do it. In the fish and wildlife business we know only too well that man was given dominion over the beasts of the field and the fowls of the air, and we are constantly reminded that he was not given dominion over himself. That is something he has to achieve."

I think it's incumbent on every one of us who participated in this first pollution control conference to help in that achievement by every means in our power, of which persuasion is by far the greatest instrument.